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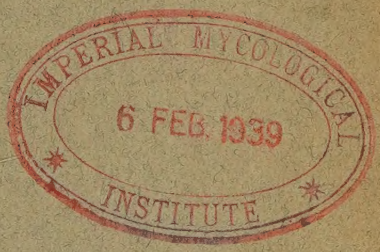

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PLANT-TO-THE-ROW TESTS ON SEEDLINGS OF STRAWBERRY

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FIVE PLATES

Strawberry improvement is comparatively a recent development of barely 50 years standing. The breeding of new varieties and the novelties offered to the trade, from time to time, were generally accomplished by hybridization. It should be borne in mind that this improvement by crossing was done in countries highly adapted to strawberry; only Canada accomplished certain improvement through seedling selection.(1)

At the Baguio Plant Industry Experiment Station, Baguio, Mountain Province, Philippines, where the most extensive culture of Philippine strawberry is located, the main problem seems to be adaptability, considering the fact that the climatic and soil conditions in Baguio are far remote from those obtaining in the well known strawberry regions of the world. Before any improvement by hybridization can be instituted, it is necessary that varieties be adapted first. Indicative of the hazards involved in strawberry culture is the fact that many of the varieties tried have lost some of their outstanding characters and qualities at home while some have acquired undesirable ones, such as, turning from sweet to sour berries or losing the runner production. Of 31 separate introductions from the United States and elsewhere, only about one-half dozen are doing fairly well.(2)

PREVIOUS WORK

It would be equally interesting and instructive to quote pertinent parts of the initial work on strawberry seedlings here(2), to be able to comprehend the real objective behind the present work:

"Since all our fields of strawberry were the result of continuous asexual propagation from plants highly adapted and bred from the countries of origin, we have not made any change in their reaction to the environment. Since a plant is both a product of heredity and environment(3), it would seem that sexual propagation by the use of seeds will make a change in the resulting plants. We may grant that some of the seedling plants are first generation hybrids, due to occasional cross fertilization in the field and exhibit heterosis or hybrid vigor. For continuous asexual propagation of these hybrid seedlings, they will remain always first generation hybrids, exhibiting the desirable hybrid vigor, which will be for the better.

"It is believed that with sexual propagation, the new environment may have been impressed in the seeds, or the adaptability to the new set of conditions could be obtained more readily by the use of seedling material than the asexually propagated material for several years. The great variability exhibited by these seedlings, the recovery of certain characters or the obtaining of new ones—all prove that improvement in several characters may be obtained by the rigid selection of the best seedlings of these varieties.

"For improving our indifferent varieties, exhibiting poor or fair adaptability, this method of propagation opens untold possibilities."

THE ORIGIN OF THE VARIETIES USED

In order to determine the origin of the varieties studied and to have a basic understanding of their individual performances when subjected to the improvement by the use of seedlings, the only available data culled from an exhaustive work on strawberry improvement in the United States are quoted hereunder(1).

"*Wilson.*—Oldest cultivated variety, introduced 75 years ago; productive, firm-fruited, adapted to widely different conditions. One of the varieties responsible for the extension of strawberry culture.

"*Missionary.*—Found in the wild as chance seedling. May have originated from seed of cultivated varieties or as the result

of bees carrying pollen of cultivated sorts to the native strawberry.

"*Mastodon.*—Introduced in 1924. Kellog Prize × Superb. Productive, everbearing, and produces runners freely.

"*Bellmar.*—Introduced in 1931. Missionary × Howard 17. Attractive, good flavor, large.

"*Big Joe.*—No data. (Introduced in 1931 at Baguio from Allen Nurseries and Seed House Geneva, Ohio).

Fairfax.—Introduced in 1932. Unknown origin. Vigor, high flavor, disease resistant."

OBJECT

The object of these tests, being a continuation of our seedling selection as appearing in this Journal(2), is to isolate some adapted and desirable strains from the second selection of seedlings of P. I. 9,773–Wilson P. I. 14,256–Missionary, P. I. 12,251–Mastodon, P. I. 12,249–Bellmar, P. I. 10,746–Big Joe, and P. I. 12,247–Fairfax.

TIME AND PLACE

This covers the third year of the work, conducted during the strawberry season from August 1937, to May, 1938, at the Baguio Plant Industry Experiment Station, Baguio, Philippines.

MATERIALS AND METHODS

The few seedling strains, namely: 8 of Wilson, 9 Missionary, 8 Mastodon, 4 Bellmar, 2 Big Joe, and 3 Fairfax, being the only ones selected after the second season, were cultured separately in test rows.

It should be understood at the outset that it was impossible to obtain equal number of plants for each test row, because of the individualistic character of each seedling in its suckering ability and runner propensity.

On August 28, 1937, the selected seedlings were separately planted in rows 17 m. long, and 60 cm. between the rows, and the plants were set 30 cm. apart in the rows. The ridge, rather than the bed culture was used in order that the plants of the selections would be equally distanced and to insure more uniform conditions. Every third row was planted with the original stock of asexually propagated material of each variety to serve as check. Some strains occupied one full row, others a part of a row, and in one case one strain occupied two rows. All the rows were uniformly fertilized just before the blooming period

about the end of October, 1937, with Fertilica (10% N—10% P_2O_5–24% K_2O) at the rate of one ton per hectare.

While the strains consisted of varying number of representatives which was inevitable, the observations taken were based on the plant as the unit. These were related to their uniformity or non-uniformity as shown by all the sister plants of each strain, comparative vigor of the plants, time of bearing, size of berry, productiveness, and other distinguishing characters. These observations were convincing enough, as they showed distinctly individualistic characters. Likewise, the average yield per plant of each strain was taken as the unit of yield and the basis of comparison, instead of the whole production of each test row. Picking of the berries of each test row was done separately thrice a week. The harvested crops were brought to the laboratory and were separately weighed and recorded. For obvious reasons, the probable errors of the test rows were not calculated and only the arithmetical average is given for each strain. In the matter of yield, the strain tests of the best seedlings to be conducted in the following season would give more reliable yield results.

The results of the test rows, showing their condition with respect to the uniformity of the sister plants, the number of plants of each seedling strain, the total yield for five months and the average yield per plant are shown in the following table:

TABLE 1.—*Seedling strain numbers of the different varieties, the condition of the rows, number of plants per strain, total yield of the strains in kilos and the average yield per plant in kilos.*

	Wilson									
Seedling strain No.	Check	3	14	5	11	16	18	Check	19	22
Condition of test row	[1] fu	[2] nu	[3] u	u	nu	u	fu	fu	u	u
Number of plants	45	8	13	29	24	21	27	48	20	27
Total yield December 11, 1937 to May 4, 1938	4.23	0.28	3.67	7.11	2.54	3.59	4.18	6.49	6.29	6.92
Average yield per plant	0.094	0.035	0.282	0.245	0.106	0.171	0.155	0.135	0.314	0.256

	Missionary												
Seedling strain No.	Check	$\frac{L7}{2}$	8	16	9	Check	[4] 13	Check	17	19	Check	23	$\frac{V}{7}$
Condition of test row	nu	fu	fu	fu	u	fu	u	fu	u	u	fu	u	nu
Number of plants	48	21	53	12	42	44	100	50	55	43	54	43	10
Total yield December 11, 1937 to May 4, 1938	9.35	4.65	9.46	3.34	14.96	9.40	44.40	10.16	14.65	13.65	9.95	10.95	0.73
Average yield per plant	0.195	.221	0.179	0.278	0.356	0.214	0.444	0.203	0.266	0.317	0.184	0.255	0.073

[1] fu = fairly uniform; [2] nu = non-uniform; [3] u = uniform; [4] occupied 2 rows.

TABLE 1.—*Seedling strain numbers of the different varieties, the condition of the rows, number of plants per strain, total yield of the strains in kilos and the average yield per plant in kilos.*—Continued.

	Mastodon									
Seedling strain No.	Check	2	4	6	8	13	14	Check	17	15
Condition of test row	nu	fu	u	u	u	fu	nu	nu	fu	fu
Number of plants	53	20	10	19	12	9	23	50	40	11
Total yield December 11, 1937 to May 14, 1938	4.22	2.30	1.52	5.47	2.39	1.36	1.87	4.04	5.98	1.50
Average yield per plant	0.080	0.115	0.152	0.288	0.199	0.51	0.081	0.081	0.149	0.136

	Belmar					Big Joe			Fairfax			
Seedling strain No.	Check	1	11	8	3	Check	8	10	Check	1	2	3
Condition of test row	fu	nu	u	nu	u	fu	u	u	nu	nu	nu	nu
Number of plants	60	24	22	7	53	23	12	9	28	9	4	9
Total yield December 11, 1937 to May 14, 1938	4.54	1.45	4.20	0.37	8.78	1.65	1.75	1.23	1.58	0.56	0.18	0.10
Average yield per plant	0.076	0.060	0.191	0.053	0.166	0.072	0.146	0.137	0.056	0.062	0.045	0.011

[1] fu = fairly uniform; [2] nu = non-uniform; [3] u = uniform; [4] occupied 2 rows.

OBSERVATIONS AND INTERPRETATIONS OF RESULTS

As there were six varieties studied alongside their respective selected seedling strains, the observations were made separately among the strains of each and, likewise, the comparison was made among them and their respective check rows.

Wilson seedling strains.—There were indications of some variability among the eight selected strains tested. One remarkable variation noted was the varying size of the leaves; some strains showed larger leaves than the others. In comparison with the check rows, the seedling strains did not show appreciable disparity. In the productivity and the size of berries, there were marked differences. Seedlings Nos. 3 and 11 gave much lower yields than the checks. On the other hand, Strains No. 5, 22, 14, and 19 in the ascending scale, gave superior average yields per plant over the check rows. As a rule, the strains showing uniform plants gave the highest yields, and this fact held true for all the high yielding strains of all the varieties.

Missionary seedling strains.—Among the varieties studied the Missionary seedling strains showed the widest variability in practically all characters and qualities (Plate I). None of the seedling strains showed much similarity with the asexually propagated material serving as checks. The latter were very much smaller in foliage spread and shorter. They produced their distinctive dark red colored, firm-fleshed, and sour berries. In foliage development, vigor, height, yield, shape, size of berries, the seedling strains showed marked superiority over the original imported Missionary variety (Plates 1 and 5). With only two exceptions, the average yields of the seedling strains were higher than those registered by the checks. Among the six varieties, Missionary showed the most promising strain, in productiveness with an average yield of 0.444 kg. per plant. Seedling No. 13 was not only the most productive among Missionary seedlings but also topped all other strains of all the varieties studied. (Plate 2.) This fact becomes all the more remarkable, because the average yield was secured from 100 plants, representing the largest number of sister plants for any strain tested (Plate 1). The berries though small were very abundant and sweet (Plate 5). May not these characteristics be those of the wild progenitor of which this variety is supposed to have partly come? Seedling No. 2 gave the largest-sized berries among all the varieties (Plate 3). Seedling No.

17 produced large characteristically shaped berries, elongate with large middle, and pale but sweet berries. Most of the berries fall under first class as to size. (Plates 4 and 5.) Seedling No. 19 produced irregularly shaped berries. Seedling No. 8 was a sweet early bearing strain but likewise stopped fruiting earlier than the other Missionary selections.

The runner propensity was noted to be a distinctly strain characteristic—found in some selections such as No. 13 while totally absent in others such as No. 8.

Most of the seedling strains produced sweet berries, a radical departure from the uniformly sour taste of the original Missionary constituting as it were, a significant advance in its amelioration.

Mastodon seedling strains.—Although the differences were not so marked as in the Missionary seedlings, Mastodon exhibited some variation in comparison with the checks. This should not be surprising as Mastodon is the result of a cross of two well known varieties. All the seedling strains outyielded the check rows. The greater adaptability to local conditions and the superior yield are the advanced steps in the improvement by the use of seedlings. Seedlings No. 13, 4, 8, and 6, in the ascending order, were decidedly superior to the other Mastodon strains and the checks.

Bellmar seedling strains.—Of the few seedling strains tested, Nos. 3 and 11 turned out to be productive and good strains.

Big Joe seedling strains.—The only two selected strains cultured were superior in yield to the check row.

Fairfax seedling strains.—No notable improvement was observed in the selected strains. This is a variety of high quality, but unfortunately unadaptable to our local conditions.

In order to increase rapidly the few promising strains of the different varieties, seeds of these were collected separately and were dried and later sufficient quantity of each was sown in seedflats and in the glasshouse. It is not intended to mix the plants of these F_1 seeds with original seedling strain selections, as it is not known if they will turn out the same plants. For one thing the seeds were collected from plants that were not selfed.

SUMMARY

The results of the second-year selection of seedling strains of Wilson, Missionary, Mastodon, Bellmar, Big Joe, and Fairfax are given.

Under Baguio conditions, adaptation and improvement of strawberry varieties can be accomplished by the use of seedling selections, i. e., sexual propagation as opposed to asexual.

After the adaptation work and selection of desirable strains, hybridization, as another method of improvement, should be the next logical step.

As a rule, uniformity of the sister plants of each strain was a condition conducive to high yield.

The following seedling strains are promising:

Wilson Nos. 5, 22, 14, and 19.
Missionary Nos. 17, 19, 9, and 13.
Mastodon Nos. 13, 4, 8, and 6.
Bellmar Nos. 3 and 11.
Big Joe Nos. 10 and 8.
Fairfax No. 1.

The above-mentioned strains need to be tested in bigger plots for more reliable comparison of yields and desirable characters and qualities.

The plants of the F_1 seeds should not be mixed with the corresponding seedling strains propagated asexually in the test rows, unless they prove to be the same in all particulars and give the same performance.

A limited distribution of the F_1 seeds, however, to propitious regions and to lower altitudes should be made in order to study their behavior, especially in the latter region. For this purpose, some seeds of Missionary selections were sent for trial to Lipa Coffee-Citrus Station, Batangas, the College of Agriculture, and Bukidnon.

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ILLUSTRATIONS

PLATE 1

Test rows of Missionary seedling strains with the check rows. Note the vigorous development and vegetative luxuriance of the seedling strains in comparison with the check rows.

PLATE 2

A plant of Missionary seedling No. 13 with the leaves pushed aside to show its prolificacy. Note the abundance of small berries.

PLATE 3

A plant of Missionary seedling strain No. 2 with the leaves pushed aside to show its large berries.

PLATE 4

A plant of Missionary seedling No. 17 showing its large characteristically shaped berries. Note the enlarged middle of the berries.

PLATE 5

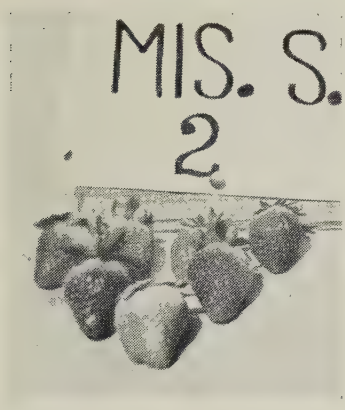
A graphic comparison of 7 berries each of four Missionary seedling strains and of the check. Note the varying sizes, shapes, and color; largest size of No. 2 and similarity of color with the check; the characteristic shape, large size, and paleness of No. 17; the irregular shape of No. 9; and the small sized berries of No. 13, smaller even than those of the check.

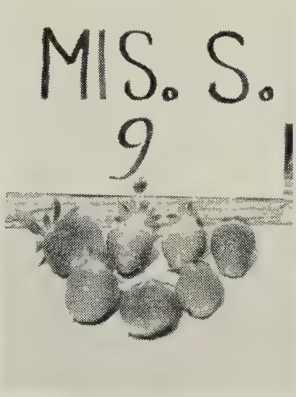
PLATE 1

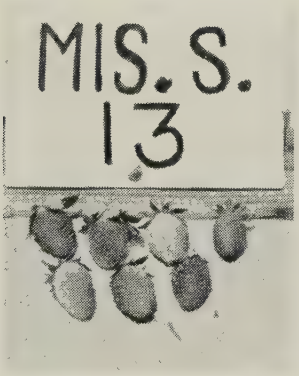
PLATE 2

PLATE 3

PLATE 4







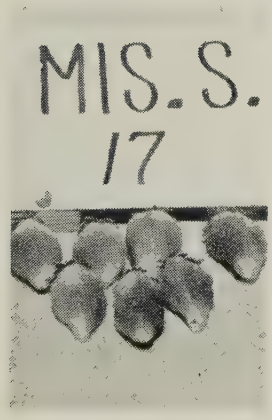


PLATE 5

VIABILITY OF SEEDS OF COTTON AS AFFECTED BY MOISTURE AND AGE UNDER DIFFERENT METHODS OF STORING *

By Floro B. Flores
Of the Bureau of Plant Industry, Manila

The preservation of the viability of cotton seeds for the next planting season has always been the concern of cotton planters. The planting of viable seeds helps to minimize, to a certain extent, the time, energy and money spent in the raising of a crop. The farmer is also assured of a fair margin of profit by curtailing the increment cost of various farm operations which might have been put to a better purpose. Thus, seed dealers throughout the country in order to rightfully maintain their prestige as seed distributors must have a good supply of seeds with a high percentage of germination. In case of an over supply, however, the seeds should be properly stored in order to preserve their viability until next season.

Due to the persistent complaints of planters who bought cotton seeds from this Bureau and also of our fieldmen that the seeds they secured were of poor viability the writer has undertaken this study under the direction of Dr. Vicente C. Aldaba, former Chief, Fiber Research Section. This study, therefore, was conducted with the end in view of finding an effective, economical, and practical way of storing cotton seeds under local conditions which might eventually supplant the crude way commonly practised by our farmers. Should the proposed plan for a government owned cotton seed farm materialize with the object of producing one single high-grade uniform variety of cotton crop throughout the Philippines, the results of this study shall eventually prove useful.

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* This study has been undertaken under the direction of Dr. Vicente C. Aldaba, former Chief, Fiber Research Section, Bureau of Plant Industry, Manila. The writer wishes to acknowledge the valuable services of Messrs. Eladio Sablan and Pedro A. Rodrigo, Assistant Agronomists, Bureau of Plant Industry, Manila, for their advice and coöperation in the preparation of this paper.

This study was carried out in the Fiber Research Section, Bureau of Plant Industry, Manila. The seeds were prepared for storage on May 26, 1936 to June 6, 1936. The study ended on June 18, 1937.

REVIEW OF LITERATURE

The cottonseeds, as far as the writer could ascertain, has never been a subject of seed storage experiment in the Philippines.

Wester (1924) states that in the Temperate Zones practically all seeds may be dried and still retain their viability, whereas in the Tropics the seeds of many important plant species, such as tea, coffee, cacao, mango and mangosteen lose their germinative power if they are allowed to dry out. According to Vibar and Rodrigo (1929) the viability of seeds decreases rapidly in the Philippines because of high humidity-temperature conditions prevailing throughout the year. They reported that farm crop seeds like rice, corn, mongo, cowpea, tapilan, soybean, etc. were able to maintain their viability very much longer when stored in air-tight container than when kept in cloth bag. Coronas (1920) gave as the average annual rainfall of the Islands about 2,366 millimeters; the relative humidity, 80 per cent; and the temperature, 26.9° C. Morada (1924) in an experiment on the effect of sun-light on the germination of papaya seeds showed that seeds under total shade during the whole day did not germinate but on exposure to sunlight for one-half day, they germinated. Brand and Sherman (1913) stated that mature seed-cotton could be stored with perfect safety if care was taken to have the seeds free from atmospheric moisture when stored. They further stated that the practical point to be observed was that cotton from which planting seed is to be saved must be thoroughly dried before bulking or must be spread out in thin layers as to prevent any noticeable development of heat if the germination of the seeds is not to be affected.

The use of concentrated sulphuric acid (commercial) for delinting cottonseed at short duration has no effect on the germinative power of cottonseeds as found out in another experiment conducted by the writer. Another worker has shown that sulphuric acid treatment has an stimulating effect on the germination of cotton seeds when soaked for 20 minutes.

Simpson (1935) in an experiment conducted at James Island, near Charleston, S. C., found that freshly opened cotton bolls

contain a considerable percentage of dormant seeds. However, this dormancy, according to him, may be eliminated by drying and storing the seeds for a short period.

In studying the moisture content and germination of cotton seeds during the period of boll opening at the United States acclimatization field station near Charleston, S. C., Simpson (1935) found that germination tests made on the seeds immediately after they were harvested were unreliable. He further stated that fresh seeds germinated very slowly, and many seeds though apparently sound, failed to germinate in the germination chambers even after 24 days. However, when fresh seeds were thoroughly air-dried and stored for a few weeks, better germination was obtained.

Simpson and Stone (1935) found that seeds from bolls just opening, when dried and stored for a short time, gave higher percentage of germination than the seeds which have been exposed for a longer period in the field. They further stated that seeds from bolls harvested when they were just opening during a period of dry weather gave higher percentage of germination than the seeds from bolls harvested when they were just opening during a rainy weather.

Simpson (1935) showed that storage experiments with Sea-island and upland cotton seeds under the humid condition prevailing at James Island, South Carolina, showed that in ordinary storage, cotton seed deteriorates rapidly after 2 years. A definite relation is indicated between the moisture content of the seeds during storage and the rapidity of deterioration. Sea-island cotton seeds, with a moisture content reduced below 8 per cent, when stored in tin container to prevent the rapid re-absorption of moisture, retained their germinative power with only slight impairment for $4\frac{1}{2}$ years. Upland cotton seed stored under various conditions and containing from 8.75 to 13.78 per cent moisture deteriorated rapidly when the moisture in the stored seeds remained about 10 per cent. Dried seeds stored to prevent re-absorption of moisture showed only slight deterioration after $2\frac{1}{2}$ years. Seeds which contained 13.78 per cent moisture and stored to prevent drying lost completely their viability in 9 months.

MATERIALS AND METHODS

Definition of terms used.—"Delinted cottonseed" is the term used here to mean cottonseed stripped of its lint by means of concentrated sulphuric acid for three minutes duration, washed

with tap water to remove the excess acid and later dried. "Cottonseed" is the seed after the cotton fibers or lint are removed by the process known as ginning. Whereas, "seed-cotton" is the term applied to seeds still bearing the cotton fiber picked from ripe bolls.

Five sacks of one-month-old (from date of harvest) "Kapas Purao" seed-cotton, weighing 30 kilos each were used in these tests. Using one-month-old seed samples for the germination tests would eliminate dormancy as a factor. The material used was harvested in the crop season of 1936 from Oriental Misamis, Mindanao.

The bulk of the seed-cotton was mixed thoroughly, stored and selected, discarding the stained cotton, so that only sound seed was used. They were equally divided into three samples. One-third which was used for samples 3 and 6, remained as seed-cotton; the second third was ginned in an Eagle No. 10 cotton gin and was hereafter termed as "ginned cotton", or "Cotton-seed" and was labeled samples 2 and 5; the remaining one-third was also ginned and delinted with sulphuric acid (commercial) for 3 minutes duration and was hereafter called as "delinted cotton-seeds" and was labeled as samples 1 and 4.

The delinted cottonseeds were immediately washed several times with tap water to insure the thorough removal of the excess acid. Sulphuric acid (commercial) was used as an effective means of removing the linters without hampering the germinative power of the seeds. The seed once removed of its linters appeared as bare seed similar to kapok seed. The bare delinted seeds were then spread in thin layers to dry under shade.

Samples 1 and 4, 2 and 5, and 3 and 6 were each further divided into two equal parts representing the sun-dried and air-dried samples. One-half of each was spread in abacá burlap in thin layers to dry under shade. The other halves were exposed to the sun for approximately 7 hours each day. The process was continued for five consecutive days, thereafter.

To prevent as much as possible the re-absorption of moisture from the air, especially in the case of the sun-dried samples, approximately, 30–40 and 50 grams portions of samples 1, 2 and 3, were all separately kept in cellophane envelopes. Thorough mixing of each sample was necessary to insure a composite sample. Composite samples in cellophane envelopes were immediately and correspondingly stored in properly labeled tin cans

with tight fitting lid. The cover was later zealed with melted paraffin. In a practical way, petroleum or gasoline cans could serve the purpose effectively having the advantage of easy shipment to interested parties without affecting the viability of the seeds. The air-dried samples were separately stored in made-to-order abacá sacks.

Initial moisture and germination tests were made on each sample, both for the sun-dried and air-dried, on May 24, 1936. Subsequent moisture and germination tests were made from the same samples after 6 months of storage and approximately 3 months interval, thereafter.

RESULTS

This paper presents a summary of the results of one year study in Table 1 which gives the average moisture contents and the average percentage of germination of the different kinds of cotton-seeds (variety Kapas Purao) under different methods of storing.

AIR-TIGHT CONTAINER VERSUS BURLAP SACK

The results of this experiment show that under conditions prevailing at the Central Experiment Station, Bureau of Plant Industry, Manila, sun-dried seeds stored in air-tight containers retained their viability which made them still suitable for planting purposes after one year in storage. The air-dried seeds stored in burlap sacks on the other hand, had very low percentage of germination and thus could not be of good use for planting purposes. According to Simpson (1935), the type of storage did not materially affect the keeping qualities of the seeds except as it prevented the reabsorption of moisture. He further stated that there was no appreciable difference between the germination percentages of air-dried seeds stored in sealed can and air-dried seeds stored in a burlap bag. This is contrary to the findings reported in this paper.

1. *Moisture content of seed.*—The data in Table 1, show that for the sun-dried seeds stored in air-tight containers, there was a gradual rise, although slight, in the moisture content during the period of storage. The probable explanation for this, is that the samples though stored in air-tight containers re-absorbed moisture to a certain degree not from the atmosphere but from the moisture liberated from the paste used in sealing the cellophane envelopes. For a period of approximately one year, the moisture content of the sun-dried seeds stored in air-tight containers

TABLE 1.—*Viability of the seeds of cotton as affected by moisture and age under different methods of storing at the Bureau of Plant Industry, Manila.*[1]

Date	Sundried (Stored in air-tight containers)						Airdried (Stored in bu.lap sacks)					
	Sample 1 (Cottonseed, delinted)		Sample 2 (Cottonseed)		Sample 3 (Seed-cotton)		Sample 4 (Cottonseed, delinted)		Sample 5 (Cottonseed)		Sample 6 (Seed-cotton)	
	Average moisture	Average germination	Average moisture	Average germination	Average moisture	Average germination	Average moisture	Average germination	Average moisture	Average germination	Average moisture	Average germination
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
May 24, 1936 (initial)	5.47	89.50	5.11	92.30	4.29	94.40	8.57	90.10	8.13	91.80	7.89	93.30
December 1, 1936 (6 months)	7.24	59.00	6.87	68.04	4.91	91.96	12.08	27.00	10.32	38.30	11.74	49.70
March 18, 1937 (9 months)	8.01	63.18	8.10	72.40	7.50	90.07	11.70	11.30	10.65	14.70	10.62	16.60
June 18, 1937 (1 year)	9.66	43.88	8.86	63.10	8.33	80.58	13.46	1.33	12.63	2.66	10.91	14.00

[1] Data on germination are reported as averages of five trials in triplicate, and moisture percentages as averages of five trials in duplicate.

ranged from 5.47 to 9.66 per cent for cottonseed (delinted), 5.11 to 8.86 per cent for cotton-seeds, and 4.29 to 8.33 per cent for seed-cotton.

2. *Relation of moisture to germination.*—The importance of moisture to seed deterioration is well illustrated in figure 1. A

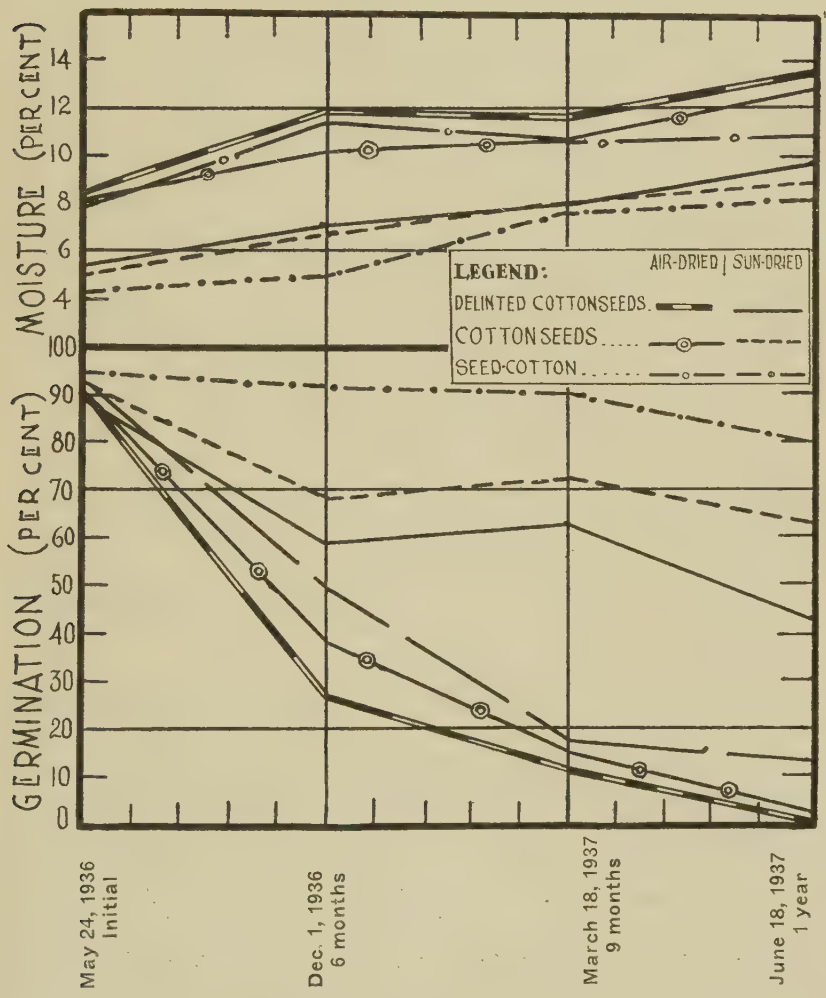

FIGURE 1. Relation of moisture content to germination.

definite relation is indicated between the moisture content of the seeds during storage and the rapidity of deterioration. Figure 1 shows that a rise in the moisture curve is followed by a fall in the germination curve. It will be noted also that seeds stored in air-tight containers, having re-absorbed moisture below 9 per cent, materially lengthen the time that they could be safely

stored. This corroborates the findings of Rodrigo (1935) on some farm crop seeds when he found that the percentages of germination of rice, corn and some beans were maintained over 70 per cent after storing in sealed container from 57 months (4 years, 9 months) to 132 months (11 years).

No very positive sign of deterioration in viability were noted after 6 months of storage in the case of seed-cotton stored in air-tight containers. However, seeds stored in burlap sacks and subjected to fluctuation in atmospheric humidity deteriorated rapidly at the end of 6 months in storage especially when the moisture content in the stored seeds continually increased above 10 per cent. Simpson (1935) has proven also that a moisture content in excess of 10 per cent is a critical factor in the longevity of stored cotton-seeds. Delinted cotton-seeds stored in burlap sacks for one year increased their moisture content from 8.57 to 13.46 per cent, and this gave 1.33 per cent germination only. It indicates that a moisture content of 13 per cent is detrimental to the viability of stored delinted seeds.

RELATION OF VIABILITY TO KIND OF SEED

A comparison of the results obtained with sun-dried seeds stored in air-tight containers in Samples 1, 2 and 3 shows appreciable and marked differences in germination percentages throughout the tests. As will be noted in Table 1, sample 1 (delinted) gave lower per cent germination than sample 2 (cotton-seed). Sample 3 (seed-cotton) has maintained the highest germination throughout the tests.

The decrease in viability became evident in sample 1 (delinted seed) during the period from May 24, 1936 to June 18, 1937, the germination percentage as of June 18, being 45.62 per cent less than the initial germination. The initial germination of sample 2 (cotton-seed) when placed in storage on May 24, 1936, was 92.30 per cent but dropped to 63.1 per cent on June 18, 1937, or 29.2 per cent less than the initial germination. A very significant result was obtained in the case of sample 3 (seed-cotton) which was stored in air-tight containers. The viability of the seeds was retained with very slight impairment up to June 18, 1937. At the beginning of the test, the germination was 94.40 per cent. Over a period of approximately 9 months after storage, the same sample gave 90.07 per cent germination, being only 4.33 per cent less than the initial germination. However, the same seed-cotton on June 18, 1937 gave a germination of

80.58 per cent with a moisture content of 8.33 per cent at the conclusion of the tests.

Air-dried seeds which were stored in burlap sacks gave, at the beginning of the tests, the following percentages of germination: Sample 4, (delinted-seed) 90.1 per cent; sample 5, (ginned seed) 91.8 per cent; and sample 6, (seed-cotton) 93.3 per cent. After 6 months of storage, these same samples, with the exception of the seed-cotton, in practically all tests, showed pronounced decrease in germination that they were practically useless for planting purposes. (Table 1.) These decline at an increasingly rapid rate continued after 9 months up to one year of storage. The latest determination made as of June 18, 1937 gave the percentages of germination as follows: Sample 4 (delinted seed) 1.33 per cent; sample 5, (ginned seed) 2.66 and sample 6, (seed-cotton) 14.0 per cent; being 88.77, 99.14 and 79.3 per cent, respectively, less than the initial germination as of May 24, 1936.

The results of the foregoing experiment show that the seed-cotton recorded the highest percentage of germination while the delinted cotton-seed recorded the lowest. These were noted both in air-tight containers and in burlap sacks. It is very evident that the linters of cotton-seed and the lint of seed-cotton are important factors in preserving the viability of the seeds and in preventing the re-absorption of moisture by the seed proper.

SUMMARY

The storage experiment with cotton-seed of "Kapas Puṛao" variety under conditions prevailing at the Central Experiment Station, Bureau of Plant Industry, Manila, showed that sun-dried seeds stored in air-tight containers whether delinted, ginned, or seed-cotton, retained sufficiently good viability for planting purposes after one year in storage; while the same kind of seeds kept in burlap sacks were useless for planting purposes after six months in storage.

Sun-dried and air-dried seed-cotton maintained higher percentage of viability than either ginned or delinted cotton-seeds in practically all the tests, as the storage period was prolonged.

A definite relation was indicated between the moisture content of the seeds during storage and the rapidity of deterioration. Maintaining the moisture content of the cotton-seed during storage below 9 per cent as in air-tight containers materially

lengthened the time that the seeds could be safely stored. Seeds subjected to fluctuations in atmospheric humidity as those stored in abacá burlap deteriorated rapidly especially when the moisture content in the seeds continually increased above 10 per cent. Air-dried delinted cotton-seed containing 13.46 per cent moisture gave only 1.33 per cent germination after one year in storage.

RECOMMENDATIONS

It is recommended that cotton-seeds for planting purposes should be kept in air-tight containers in order to maintain a good supply of viable seeds.

More detailed study on storage of seed-cotton to solve the problem of bulkiness of the stored material should be undertaken.

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NOTES ON THE PROPAGATION OF THE PONDEROSA CHICO

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FIVE PLATES

The Ponderosa chico, *Achras zapota* Linn. var. *Ponderosa*, in the Philippines originated from seeds introduced into the Islands in 1912 from the botanical garden at Buitenzorg, Java. The oldest tree which was planted in the yard of Mr. Silvio Lopez of Los Baños, Laguna, first fruited in 1927 or around 15 years after planting. This tree may be considered as the original parent stock of the few Ponderosa chico trees now distributed in the Islands.

The average-sized fruit of the tree is exceptionally big and of good quality (Plate 1, fig. 2). Thus, when Gonzales [1] described it in 1932, he called it "an improved seedling variety of chico." An averaged-sized fruit of this tree is easily four to five times larger or heavier than an average-sized native chico fruit. The tree, however, seems to have one defect in that it is rather a shy bearer. Nevertheless, despite this defect, persons who have seen and tasted its fruits are practically unanimous in their desire to include this chico variety in their backyard orchard. Of course, because of the great demand for planting materials, the tree has always been heavily marcotted on and, therefore, has never been given an opportunity to show its normal ability to bear fruits. The great interest of people who have seen or known this chico together with the fact that the supply of planting materials was then limited prompted the writer to try different methods of propagating it.

The data presented in this paper include observations made from December, 1928 to August, 1938, a period of almost 10 years. Some of the observations were made in Batac, Ilocos Norte, where two seedling trees were planted and in Los Baños, Laguna. Most of the data here presented, however, were obtained in the backyard orchard of the writer in San Juan Heights, Rizal Province.

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[1] Gonzales, L. G. An improved variety of chico (*Achras zapota* Linn. var. Ponderosa. Phil. Agr. 20: 604–605. 1932.

METHODS OF PROPAGATION EMPLOYED

Marcotting.—This is the oldest and until recently, the only method of propagating the native chico. Naturally, this method was employed in securing planting materials from the original tree of Mr. Lopez. The writer was fortunate, after several attempts, to have been able to secure three marcotted branches at a time. These branches were marcotted in October, 1932 and were severed from the parent tree in September, 1933 or about 11 months thereafter. These were planted on January 1, 1934 (Plate 1, fig. 1).

Of the 10 marcotted branches from three- to four-year old marcotted trees in San Juan Heights, Rizal, six succeeded in producing roots while four died, representing 60 per cent success. The period from marcotting to cutting varied from 6 to 14 months. It may be mentioned that the marcotting was always done in May and June, or in other words, at the commencement of the rainy season. It may also be pertinent to state that the soil used in marcotting had a great deal to do in the rapidity of the branch to root. Where a mixture of 50 per cent loam and 50 per cent fine sand was used, the roots were seen to strike out the ball of earth in 4½ to 5 months after marcotting, whereas it took from 7 to 12½ months for the roots to strike out where loam and clay soils were used.

In cases where valuable and rare varieties are propagated like the Ponderosa chico, marcotting is a very extravagant and slow method of propagation. It is also highly devitalizing to the tree especially when it is still comparatively young.

GRAFTING AND MARCOTTING

Raising seedling for stock.—Due to lack of some definite information as to the most suitable stock for Ponderosa chico, three varieties were tried, namely, St. Croix, Native and Ponderosa. The seeds of St. Croix and Ponderosa germinated in from 16 to 32 days while the Native chico seeds germinated in from 25 to 44 days. The St. Croix and Ponderosa seedlings were found to be fast growers and under good nursery conditions, they were ready for inarching in 11 to 15 months after sowing the seeds (Plate 2, figs. 1 and 4); in 20 to 24 months they attained the size suitable for grafting. The Native chico seedling, on the other hand, was not ready for inarching until it was 30 to 36 months old (Plate 2, fig. 3).

In this connection, it may be of interest to present here the girth growth of 6 grafted Ponderosa chico trees ranging in age from 2 to 3 years with St. Croix chico as stock, and of 4 three-year old inarched with Ponderosa chico as stock. In the former where St. Croix chico was used as stock, the average diameter of the stock and scion taken about one inch (2.5 cm.) from the point of union were 2.3 and 2.1 centimeters, respectively. The average diameters of the stock and scion in the latter case (with Ponderosa stock) were 4.5 and 4.2 centimeters, respectively. While it may be rather premature to draw any definite conclusion now, at least, present indications show the great possibility of the Ponderosa and St. Croix chico seedlings as stock for the former.

Grafting.—The writer's first attempts to graft (cleft) the Ponderosa chico gave very low percentage of success. Due to the limited supply of stock and scion, and to the fact that the object was to obtain the highest percentage of propagated Ponderosa chico, because the work was done under private expense, this method was given up and inarching was resorted to. This, however, does not mean that the Ponderosa chico could not be propagated successfully by grafting. Perhaps, one who has acquired dexterity in the art of grafting would prefer this method to inarching especially when the source of the scion has its branches high from the ground. Trials made by skilled propagators at the Bureau of Plant Industry gave about 90 per cent success. Grafted Ponderosa chico trees planted at the Central Experiment Station, Manila, have been growing vigorously (Plate 3).

Inarching.—For beginners, inarching is the fastest and the surest way to propagate the Ponderosa chico. The whole operation is simple that it is not uncommon for a beginner to obtain 100 per cent success. With tall trees, however, the operation is rather laborious because of the fact that the potted seedling which is being used as stock has to be carried up in the tree or be provided with a support or platform. In the case of the Ponderosa chico where both the stock and scion are rare and the resulting inarched plant is very costly, the use of inarching even in its most laborious way is still justified.

Seedlings having a diameter of one-half centimeter or more at a point 10 centimeters from the base are ready for inarching. With a sharp knife, a tangential cut about five centimeters in

length is made on one side of the stem of the stock about 10 to 15 centimeters from its base. The cut should be clean and deep enough to include a part of the wood. A similar tangential cut should be made on the branch or twig (scion) to be inarched. The stock and scion are then put together on their "cuts" fitting them snugly so that their cut barks coincide with each other. Then they are tied together with budding tape (Plate 4, fig. 1).

The rapidity of the union between the stock and scion depends upon the nature of their growth. Rapid growing stock and scion, as is the case at the beginning of the rainy season effect more rapid union. A more or less perfect union was observed to have been effected in 35 to 60 days. Before the branch is cut, its base (below the point of contact) should be gradually cut. The object is to force the inarched branch to draw its water supply from the stock. It was also found advantageous to cut the top of the stock right above the point of union about a week or so before completely severing the inarched branch (Plate 4, fig. 1). The cut should be clean and as close to the point of union as could possibly be made. For obvious reasons, painting the cuts with white lead or with any ordinary paint is essential. If the union has been complete, the base of the scion just below the point of contact could be cut clean and painted, otherwise this may be delayed for a week or so. As a precautionary measure, the newly severed inarched plant should be put in a shade for about a week, after which it should be gradually put in the open.

Seed.—The fact that the original Ponderosa chico in the Philippines originated from seed gave the writer the idea to plant the seeds of two fruits obtained from it. The seeds (nine in number) were sown in December, 1928. Eight seeds germinated and three of the seedlings were transplanted in Batac, Ilocos Norte in April, 1930, and the rest were left at the Baguio Plant Industry Experiment Station. Of the three that were planted, one died and the other two grew into big trees. These trees had a very vigorous growth. One of the trees was cut accidentally at the base while young and this caused the tree to produce low and spreading branches (Plate 5, fig. 1). Both trees began to bear flowers in May, 1936, but the first fruits were noticed only with the October, 1936, flowering.

BEARING AGE

Marcotted tree.—The seven marcotted trees that were observed at San Juan Heights, Rizal, began to flower with the

first flush after setting them in their permanent places. One fruited after one year, four after two years and two after three years. Compared with native marcotted chico, the Ponderosa grew comparatively fast. The vigorous growth of the tree may have caused the delay in fruiting, or it may be an inherent character of the tree.

Grafted tree.—Grafted trees at the Central Experiment Station began to bear flowers about 1½ years after planting. None of the trees (Plate 3, fig. 2) have so far set in fruits three years after planting.

Inarched tree.—Inarched trees were observed to begin flowering two years after planting. None of the four three-year old inarched trees, however, have so far set in fruits (Plate 2, fig. 2).

Seedling tree.—Two seedling trees planted by the writer began to bear fruits in 7½ to 8 years after planting or 8½ to 9 years after sowing the seeds. At this age the trees have attained a height of from 7 to 8 meters with a spread of 6.5 to 7 meters.

At this writing, the trees are in their second year of fruiting. Like the mother plant, they are also shy bearer, but unlike the mother tree, their fruits are much smaller; the fruits are a little bit bigger than the large-sized native chico. The superior quality of the Ponderosa chico (sweet, juicy and comparatively free from grit), however, has been maintained. Of the 50 fruits examined, 41 were single-seeded and the rest 2 seeded; none was found to have produced three seeds. Based from the performance of the two seedling trees mentioned above, it appears evident that the Ponderosa chico does not breed true to type in so far as the size of the fruit is concerned. To maintain the size of the fruit, the Ponderosa chico should be propagated asexually, either by marcotting, inarching or by grafting.

SUMMARY

The present paper includes some notes on the propagation of the Ponderosa chico covering observations for a period of 10 years.

Four methods of propagation have been tried; namely, marcotting, grafting, inarching and by seed. The Ponderosa chico has been found to respond to all these methods. Until recently, marcotting has almost exclusively been the only method of propagating the native chico.

Marcotting is an extravagant as well as a slow method of propagating the Ponderosa chico. The percentage of success was 60 per cent and it took from 6 to 14 months before the

marcotted branch was ready to be cut. A medium consisting of 50 per cent sand and 50 per cent clay loam was better than pure loam or clay soil for marcotting the Ponderosa chico.

With expert operators, grafting gives from 80 to 90 per cent success. Inarching is a surer method of propagating the Ponderosa chico, the percentage of success ranging from 95 to 100 per cent. This method is the most dependable for beginners.

Three kinds of chico were tried as stock for the Ponderosa chico, namely, Ponderosa, St. Croix, and the Native. The first two (Ponderosa and St. Croix) were found to be fast growers and are considered good stocks for Ponderosa.

Marcotted Ponderosa chico began to bear flowers with the first flush after planting, but did not bear fruits until the lapse of one to three years after planting. Grafted and inarched trees began to flower in one to two years after setting them in the field, but so far, none has been observed to set in fruits three years after planting.

Two Ponderosa seedling trees planted in Batac, Ilocos Norte, began to bear fruits in 7½ to 8 years after planting. These trees are vigorous growers; at this age they have attained a height of from 7 to 8 meters with a crown spread of 6.5 to 7 meters. The fruits of these two seedling trees were much smaller in size than those of the mother tree although the eating quality was similar.

ILLUSTRATIONS

Plate 1

Fig. 1. A four-year old marcotted *Ponderosa* chico.
2. An average-sized mature fruit of the tree, × ¾.

Plate 2

Seedlings of different chicos. *Fig. 1,* One-year old *Ponderosa; 2,* inarched *Ponderosa* just severed from the parent plant (note the close and clean cut of the top end of the stock and the untrimmed base of the scion); *3,* a three-year-old native chico seedling; *4,* a 15-month-old St. Croix seedling.

Plate 3

Ponderosa chico. *Fig. 1,* A row of two- to three-year-old grafted trees on St. Croix; *2,* a close-up view of one of the trees.

Plate 4

Fig. 1. Inarched *Ponderosa* branches, almost ready to be severed from the parent tree. (Note the tops of the stock have already been cut close to the point of union.)
2. A three-year old inarched *Ponderosa* with *Ponderosa* stock.

Plate 5

Figs. 1 & 2. Eight-year old seedling trees from the original *Ponderosa chico* of Mr. Silvio Lopez, Los Baños, Laguna. (Note the vigorous appearance of the trees.)

1

2

PLATE 1

1 2 3 4

PLATE 2

1

2

PLATE 3

1

2

PLATE 4

2

1

PLATE 5

A PRELIMINARY SURVEY OF THE WATERMELON INDUSTRY IN BULACAN AND PAMPANGA [1]

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FIVE PLATES

The growing of watermelon, *Citrullus vulgaria* Schr., locally known as Pakuan or Sandia is still a minor industry in the Islands. The watermelon marketed in Manila comes almost exclusively from Bulacan and Pampanga. In certain sections of these provinces, however, the raising of watermelon has become a great source of income of the people.

Because of its growing economic importance and the manifest interest of prospective growers and because of the increasing demand for information about watermelon growing, the writer was assigned to undertake an investigation of the watermelon industry in Candaba, Pampanga and in Bocaue, Sta. Maria, Norzagaray, Angat, Bustos and Baliwag, Bulacan. The investigation was conducted during the watermelon season of 1937–1938.

The investigation had for its object the gathering of data relative (1) to the scope of the industry, (2) the area of land actually devoted to watermelon, (3) production, (4) the varieties planted, (5) the capital invested and the labor involved in the industry, (6) the approximate number of people dependent upon it, (7) the cultural methods that are in vogue and (8) the difficulties of the growers, with the aim in view of introducing some improvements in the present cultural practices that are being employed.

HISTORY OF THE WATERMELON INDUSTRY

In the absence of printed literature covering the development of the watermelon industry, the writer resorted to gathering information from old farmers in the center of watermelon production with respect to the history of the development of the industry. The farmers interviewed were unanimous in the claim that the growing of watermelon dates as far back as the

[1] Prepared under the supervision of Mr. F. G. Galang, Chief, Horticulture Section and Mr. Pedro A. Rodrigo, Assistant Agronomist.

beginning of the last century of Spanish dominion in the Islands. The farmers in the town of Candaba, Pampanga and of those in Sta. Maria and Bustos, Bulacan claim that they first grew the so-called Meck watermelon, a naturalized variety, the origin of which is not definitely known. Later the Valencia variety was introduced by the Spaniards from Spain and these two varieties were the varieties leading in hectarage. Only limited areas of land were being cultivated then and these were confined mostly to a small portion of the Candaba swamp and along the bank of the Angat River in Bulacan.

Gradually, the cultivation of watermelon has advanced. In some towns of Pampanga as Guagua, Sta. Rita, Bacolor, Apalit, San Simon, San Luis, Arayat with Candaba in the lead, is now quite extensive. Also, in the towns of Bocaue, Sta. Maria, San Jose, Norzagaray, Angat, Bustos, San Rafael, Baliwag and Plaridel, Bulacan, watermelon is becoming a major crop.

At the present time, the watermelon area covers practically all the Candaba swamp which is dried from November to June, and some of the lands bordering it with an approximate total area of about 4,207 hectares, and along the banks of the Angat River from San Jose to Bintug, Bulacan, with an approximate area of about 1,500 hectares. Other provinces such as Nueva Ecija, Rizal, Cavite, Tarlac, and Laguna are also producing watermelon in a limited extent.

VARIETIES PLANTED

Elayda(1) in his investigation in 1929, reported three varieties of watermelon that were being planted, namely, Meck, Valencia and De Jaspe. The last variety was the most important. In the investigation reported herein, however, other varieties were found being planted. The most important among the new varieties were Magliston or De Liston, Ramie, Santa Rosa White and Kinaramelo. De Liston and Ramie have gained popularity very rapidly among growers because of their size and distinct superiority in eating quality. The writer also found three minor varieties which were unnamed, and for convenience are designated in this report as Varieties A, B and C.

DESCRIPTION OF COMMERCIAL VARIETIES

Meck.—A naturalized variety, large and elongated, tapering gradually at the peduncle end. Rind, dark-green 1 to 1.3 cm. thick, light green ribbing and netting. Texture, fine grained, juicy, without aroma and flavor, not so sweet but good when

properly ripened. Flesh, tough and red. Seed, ash-gray with black dots. Diameter, 16 to 19 cm., length 44 to 44.5 cm., weight 6 to 9 kilos. (See Plate 1, fig. 1.)

Sta. Maria.—A strain claimed to have come from Meck. Almost globular in shape, medium size. Rind, dark-green 1 to 1.2 cm. thick. Ribbing, distinct and slight netting. Flesh, red, juicy, grainy and sweet. Seeds, dark-gray with black spots and easily removed. Diameter, 20 to 22.7 cm. Length, 21 to 23.5 cm. and weight, 4 to 5.2 kilos. Appeared in Candaba, Pampanga in 1918 (Plate 1, fig. 2).

"De Jaspe."—Described by Elayda in 1918 as a hybrid between Valencia and a certain white seeded American watermelon. Melon growers in Candaba, Pampanga, however, claim that it is a strain selection from Sta. Maria produced by them in 1928. Round and large. Rind, 0.6 to 1.3 cm. thick, green with distinct dark-green ribbing and light green netting all over the fruit. Flesh, pinkish to red with sweet flavor. Can not withstand long distance shipping. Seeds, pale brown to tan in color and adhere tightly in the flesh. Half-slip mature fruit has compact pinkish flesh but sour taste. Diameter, 17 to 19 cm., length, 19 to 19.2 cm. and weight, 2 to 3 kilos. (Plate 2, fig. 1.)

Magliston or De Liston.—A strain selected from "De Jaspe" produced in Candaba, Pampanga in 1933. The fruit is large and almost round. Rind, 1 to 1.5 cm. thick, light greenish with irregular green stripes. Scar at the staminate end is large and very conspicuous. Flesh, red, juicy and sweet. A small triangular cavity is found at the center as shown in the cross-section (Plate 2, fig. 2). Color of seeds, tan or light brown. Diameter, 22 to 24 cm., length, 23 to 24.2 cm. and weight, 4 to 6 kilos (Plate 2, fig. 2).

Ramie.—A new strain found among the "De Liston," having about the same shape, color but larger and heavier than "De Liston." Distinguishing characteristic is the dot-like scar at the staminate end. Produced in Candaba, Pampanga during the 1937–1938 season. Rind, similar to "De Liston," 0.8 to 1.3 cm. thick; diameter, 24 to 25 cm.; length, 25 to 28 cm.; and weight 7 to 8.5 kilos. Flesh, compact, juicy, red and sweet. Color of seeds, light greenish brown. Good shipping quality (Plate 3, fig. 1).

Sta. Rosa White.—Large, almost spherical and white-greenish color. Rind, 1 to 1.1 cm. thick, with light green netting and

almost indistinct shallow ribbing. Flesh, grainy, juicy, red and sweet. Not good shipping quality. Strain selection from "De Liston." Color of seeds, light brown. Diameter, 21 to 23.5 cm.; length, 22 to 27 cm.; and weight, 5 to 5.5 kilos (Plate 3, fig. 2).

THE SOIL

The soils in Candaba, Pampanga where watermelons are produced are clay-loam and sandy-loam. The place is visited by flood every year, causing the higher places to be depleted because of erosion while the section of lower elevation to become fertile due to deposit of alluvial soil. This is shown by the good harvest of watermelon at Pangatang and Kabigting, regions which are lower than Capitana Culasa, where yields are of inferior quality. Large areas of watermelon field in Candaba are newly cleared land. In the towns of Bocaue, Sta. Maria, Norzagaray, Bustos, Angat and Baliwag the watermelon fields are situated along the flood plains, (tumana) of the Angat River and the type of soil is sandy-loam. This place is inundated yearly thus receiving annual deposition of alluvial soil from the Angat River.

In this investigation rich sandy-loam soil has been found to be the best for watermelons but good crops have been produced also in clay-loam soil and on newly cleared land. Soil full of decayed vegetable organic matter and soil flooded every year, such as the soil on the swamp of Candaba, and on alluvial plains (tumana) along the bank of Angat River in Bulacan have been found good for watermelon production. However, fields that were continuously cropped with watermelon for several years showed decided decline in yields. Watermelon is often termed as a "clean-up" crop for it thrives best in newly opened and cleared land.

It is the consensus of opinion among planters that the land should be fairly fertile, has a source of good irrigation and at the same time good drainage in order that it may produce good melon.

PREPARATION OF THE LAND

In general, the method of preparing the land followed by the majority of the farmers in Candaba, Pampanga is poor. The majority of them plow the land only one time and without harrowing. The more progressive farmers, however, give two plowings and one harrowing before they plant the watermelon seeds. In Bulacan, on the other hand, the watermelon fields are prepared

thoroughly. The plowing is done three times and is harrowed thoroughly until the field is cleaned and in fine tilth. Furrows are well made unlike those in Candaba, where big clamps of soil are found after the preparation of the field.

Watermelon is not too exacting a crop as regards its culture, but like other crops it responds readily to good soil preparation. To put the land in fine tilth, plowing and harrowing should be two to three times at sufficient intervals before planting. In general the preparation of land for corn is similar to that for watermelon.

PLANTING SEASON DATES AND METHOD OF PLANTING

Planting season dates vary with the locality and the commencement of the dry season. In Candaba, Pampanga, planting begins from November to February while in Bulacan from the early part of October to December.

Planting distances have been found not to vary greatly in the different watermelon areas. A few growers in Candaba plant as close as 2 by 0.5 meters. Under this method plants were found to be prolific or heavy yielders but the fruits were small. Generally the distances of planting found best suited in the commercial watermelon producing centers was 2 × 2 meters with 2 to 3 plants being allowed to hill after thinning.

Before planting, the land is harrowed and then furrows of 2 meters far apart are made. At every 2 meters in the row, holes of 30 to 40 centimeters in diameter, 3 to 5 cm. deep are made. The seeds are then scattered and pressed lightly at every center of these holes, covered with earth by hand or with a hoe. Taking the distance of 2 × 2 meters, this arrangement gives approximaely 2,400 hills to the hectare. The farmers use 1½ gantas of seeds for one hectare. The farmers call this method of planting as the "balañga system," from the shape of the earthen jar "balañga."

As a general rule, to preven losses, planting generally commences soon after the heavy rains are over, because young seedlings are easily injured by heavy rains. From five to seven seeds are planted in each hill along the furrows, to insure a good stand of plants. Thinning of plants is started at the latter part of the second week, two to three healthy seedlings are left per hill. According to Beattle,(2) a second thinning should be done leaving if possible one seedling to the hill.

Elayda(1) reported distances of 3 to 2.4 meters, 3.6 by 3 meters or 3 by 3 meters, as being used in Pampanga and Bulacan but

these distances are no longer followed because growers have found that with these spacings they get less yield.

CULTIVATION

The farmers in Candaba cultivate their fields three weeks after planting or when the plants sprout cultivation is done by means of sharp-pointed iron, used in digging around the base of the plants and by passing the plow in between the rows. In Bulacan they use the plow alone for cultivation. Some farmers cultivate only one time while others put two cultivations in their fields.

To put the soil in good condition and prevent the growth of weeds, three to four cultivations are necessary until the vines are long enough that further cultivation is impracticable. In cultivating, it should be kept in mind that watermelon plants are shallow-rooted and their roots spread out, hence, it is essential that cultivation should be done lightly, especially near the hills after the vines have begun to run freely.

WATERING

In places where there are no irrigation system as in many watermelon fields in Candaba, the fields are watered when the soil is too dry and hard for cultivation. Farmers fetch water from brooks and wells and put as many petroleum cans as a cart could hold. The cart is passed around the field and the watermelon hills are watered at the rate of ½ canful of water per hill. In the watermelon fields in Bulacan which are located along the bank of the river, the farmers have access to water. In some places as in barrios Aliwalan, Kabigting, and Pañgatang in Candaba, irrigation systems are provided. Watering is usually done a month after planting and for every week thereafter for three consecutive weeks.

MANURES AND FERTILIZERS

Commercial fertilizers are seldom used by the watermelon growers in Pampanga and Bulacan. The fields in Pampanga and Bulacan are so favored by annual floods, which leave large amount of organic matter on the fields. Farmers however, apply carabao manures in their fields, and the writer believes that this practice may be responsible for the rapid spread of a certain disease that now threatens the industry particularly in the Candaba swamps. It was Beattie (1924) who stated that

in Texas the wilt disease of watermelon grows readily in stable manure, the application of which to watermelon fields caused the rapid spread of the disease.

CROP ROTATION AND COMPANION CROPPING

Along the edges of the watermelon field in Candaba, muskmelon, squash, patola and cucumber are planted serving as borders to the watermelon plants. In Candaba, no crop rotation is practiced. However in a few places in Candaba and in San Luis, corn is planted right after the watermelons are harvested. In Bulacan beans, corn, and rice are rotated with the watermelons.

HARVESTING

Watermelons are harvested from two and a half to three months after planting. Losses are sustained by inexperienced growers because they pluck immature melons for the market. This is also true among wholesale buyers who purchase the crops before their maturity and put them in the market in unripe condition, because of their desire to get higher price. Such condition exists in Candaba. In Sta. Maria, Bulacan and the rest of the towns surveyed, farmers harvest their crops when the fruits are fully ripe or mature in the vines. The fruits harvested this way has a superior eating quality. A good indication of maturity is the change of color of the lower part of the fruit from a pale white background to light yellow. Another exterior sign of maturity is the drying of the two small leaves at the base of the peduncle. In the final analysis, however, it is the sugar content of the meat and the ripeness of the seeds, that indicate ripeness. But this test cannot be applied in a practical way, so exterior indications are the only ones by which to judge the maturity of the individual fruits. Experienced growers can tell the ripeness of the fruits by *sounding them.* With the use of his third finger he taps the fruit and by the corresponding distinct resonance produced could tell the degree of maturity.

Before the farmers begin to harvest, the watermelon field is divided into sections of about 5 to 10 rows each and the vines of every fifth or sixth row laid together so as to form aisle wide enough for carts or trucks to pass through.

It is the prevailing practice among many of the farmers to harvest early despite the immaturity of the fruits in order to

put their crops in the market ahead of the others before the market is glutted in order to command higher price. This practice is not advisable, for to have a better flavor and good keeping quality, watermelons should be allowed to ripen on the vines like those produced in Sta. Maria, Bulacan. Fruits that are harvested green have a compact, tough and watery flesh, that is a little bit sour, while fruits ripened on the vines have granulated, spongy, sugary and red flesh. The latter are better appreciated by the consumers who demand good ripe fruits. With the use of knives the melons are severed from the vines (Plate 4, fig. 2) and these are gathered at once to be piled in a shed made for the purpose (Plate 5, figs. 1 and 2). As the harvesters continue cutting the fruits, the "Tote-boys" or pickers gather them in a loading point where a cart collects them for storage in the huts, located near the field.

Considerable complaints have arisen on account of the shipment of green melons to the market. In order not to destroy the confidence of the public, the growers of early crops should give more attention to the proper maturity of the melons grown. It has also been observed that the fruits are commonly pulled off from the vines. Knives and shears can be used for cutting melons from the vines. Care should be taken to leave the stem as long as possible. As the melons are cut off from the vines they are either carried direct to the huts or the loading center. The fruits should not be allowed to stand on their base-end either in the field or on carts. Care must be taken in laying the watermelons down, and in piling them one upon another carefully to prevent bruising.

GATHERING AND LOADING WATERMELONS

All available means of transportation are employed for hauling watermelons from the field to the loading center, ranging from small carts, big carts and trucks (Plate 5, fig. 4). The usual method of loading the melons from small piles to the carts or trucks is to have two men on the ground and one on the cart or truck and simply pass the melons one at a time, from the ground to the cart or truck. Growers use a piece of canvas to cover the load of watermelons to protect them from the hot sun or rain on the way to the huts in the loading place, and rice straw in the case of cart. From this loading center, they find their way to different markets.

METHOD OF MARKETING

Some growers sell their crops wholesale before their maturity. Others wait for their ripening before disposing of them. Prices of a hectare planted with watermelon depends upon the age of the plants, size and conditions of fruits. It varies from ₱300 to ₱500 during immature stage, and from ₱800 to ₱1,000 at harvest stage. The crops are also sold wholesale and retail. Wholesale buyers buy the whole pile in the loading center and take the produce to neighboring provinces and to Manila either by cascos or trucks. In loading centers it is a common sight to see sellers and buyers bargaining for prices. Market prices vary according to the condition and size of the crops and also to the existing demand and supply. Proximity to the market also determines price.

Watermelons are sold by the number, by the carload or by truckload, in which case sellers do much guessing in determining the price so as to gain in the trade. Local market in small lots also yield reasonable return. Some growers take their crop to other places for disposal while the majority await buyers in the field. Individual fruits are sold in the loading centers at from ₱0.15 to ₱0.30 depending upon the size. A cartload of melons sells from ₱10 to ₱15 at the town and a truckload of small melons sells at ₱55 to ₱70.

PESTS AND DISEASES OF THE WATERMELONS

Watermelons like any other crops are susceptible to many injurious insect pests and diseases. A number of pests and diseases have been observed in the watermelon areas covered. Rats, ants, melon aphids and dañgao (Pampango) *Ceretia similis* (Ol.) cause considerable damage and losses to the watermelon. In Pampanga the most common insect pests are the aphids and squash beetle, *Ceretia similis* (Ol.). These pests attack the plants when they are in the seedling stage. In Bulacan, black and red ants accompanied by the melon aphids cause high mortality among young watermelon plants, thus causing the farmers to hesitate to plant on a large scale. The presence of *Fusarium* wilt of melon in the watermelon fields of Candaba, Pampanga causes large amount of losses as it was responsible for the wiping out of almost 1,000 hectares of watermelon fields in 1937–1938.

No control measures are employed to check the ravages of these insects and diseases due perhaps to the ignorance of the farmers who just leave their plants at the mercy of these insects. Farmers in Candaba, however, keep a vigilant watch in their fields during the night, driving the squash beetle that attacks their plants. This is a phase of the industry that should be looked into by the provincial and municipal officials concerned.

GOOD SEEDS—ITS IMPORTANCE AND HOW OBTAINED

The value of good seed cannot be overemphasized, but the majority of the watermelon planters do not practice seed selection. The practice of selling their crops before maturity deprive them of the opportunity to select good fruits for seed. A common practice of the farmers is to sell the best marketable melons. Hence the important work of selecting and retaining good and sound fruits for seeds is not done.

The general practice in vogue is to get seeds from rotten fruits and from small ones left over in the field. This should be discarded as this will undoubtedly result in the degeneration of the varieties being planted, thus causing low yields in spite of the fertility of the soil. However, there are farmers who get their seeds from selected fruits.

For seeding purposes only 10 to 15 fruits are needed for every family and so farmers should mark enough of good melons from healthy and productive vines for their seeds before maturity or before harvest. Only the fruits of the desired color, type, size, etc. from vines free from pests and disease should be selected for seed purposes. They should be left to ripen fully on the vines. When harvested, the seeds should be removed from the meat, soaked in water for 24 hours, thoroughly washed and sun or air dried. These seeds should be stored in air-tight containers.

THE ECONOMICS OF THE INDUSTRY

The approximate area devoted to watermelon production in Candaba and San Luis, Pampanga, were arrived at by summing all the areas of their respective watermelon fields, while those in the towns of Bulacan were obtained from the agricultural reports of their Municipal Secretaries. The number of tenants were ascertained by the area of land a tenant cultivates in their respective towns. The gross income were obtained from persons in their respective town basing their estimates during the past four years.

TABLE 1.—*Approximate area of land under watermelon cultivation, approximate number of tenants engaged in the industry and approximate gross income in 1937–1938.*

Towns	Province	Approximate area	Number of tenants engaged	Approximate gross income
		Ha.		*Pesos*
Candaba	Pampanga	4,000–4,200	2,000–2,100	500,000–900,000
San Luis	do	25–30	25–30	
Bocawe	Bulacan	30–40	60–80	
Sta. Maria	do	135–145	270–280	3,000–5,000
Norzagaray	do	190–210	380–420	8,000–12,000
Angat	do	160–170	160–170	7,000–9,000
Baliwag	do	38–45	38–45	4,000
San Rafael	do	25–38	25–38	2,000–3,000
Bustos	do	135–145	270–290	2,000–6,000
Plaridel	do	10–15	20–30	
Total		4,748–5,045	3,248–3,483	526,000–935,000

According to Table 1, the approximate area of land planted to watermelon in the places surveyed, is approximately placed at from 4,748 to 5,045 hectares. The cultivation of these areas depends, however, upon the prevailing seasonal conditions. In Candaba, Pampanga the average size being worked by a farmer is 2 hectares, while in Sta. Maria, Bocawe, Norzagaray and Bustos, Bulacan it is one-half hectare for a farmer and for the rest of the towns it is 1 hectare. On the basis of these data, there are from 3,248 to 3,483 farmers working on the production of watermelon and on the average of 4 persons in a farmer's family because the majority of the farmers are married, there are from 12,992 to 13,392 individuals dependent upon the industry. This figure excludes the extra labor during the planting, harvesting, picking and transporting of the melons.

Table 2 shows the estimated amount of capital invested, labor involved, gross and net income per hectare of watermelon field.

GROSS INCOME

As already stated in previous paragraphs the gross value of one hectare of watermelon field depends upon the condition of the plants and stage of maturity of the fruits. The farmer's average gross income for one hectare of watermelon field if he sells wholesale when the plants are just commencing to fruit is ₱400, while if he waits and sells his fruits at maturity he gets ₱900. These conditions are based in the town of Candaba, Pampanga upon the actual sale as seen by the writer.

TABLE 2.—*Economic of production per hectare.*

Items of operation	Man days	Animal days	M—₱1.00 A— .50	Value
1. Cost of seeds, 1½ gantas at ₱0.50				₱0.75
2. Preparation of land:				
a. First plowing	7	7	1.50	10.50
b. First harrowing	2	2	1.50	3.00
c. Second plowing	5	5	1.50	7.50
d. Second harrowing	2	2	1.50	3.00
3. Furrowing	½	½	1.50	0.75
4. Planting	6		1.00	6.00
5. Cultivation and weeding	6	6	1.50	9.00
6. Harvesting:				
a. Picking	15		1.00	15.00
b. Gathering and hauling	15	15	1.50	22.50
7. Transportation expenses (contract labor, at ₱1—32 carts)				32.00
8. Watering expenses (contract labor)				20.00
9. Administration expenses				90.00
Total expenses				212.00
The farmer's gross return from 1 hectare at mature stage				900.00
Cost of production				212.00
The farmer's net income from 1 hectare of watermelon				688.00

NOTE.—The estimate of cost of production is subject to change, depending upon the cost of labor in the locality.

Production costs are generally high due to the need of a thorough preparation of the land, the subsequent cultivation, and attendant care of the plant. Estimated expenses from the preparation of the lands, planting, cultivation, watering including the cost of seeds, harvesting, picking, attendant care and the cost of transporting the melons is ₱212. In many cases owing to adverse conditions and other causes the cost of production becomes greater and the yield also becomes considerably lower. Contrary to prevailing opinions, the watermelons are not a cheap crop to produce, but the returns are reasonably high at the present rates of supply and demand. Taking the town of Candaba in Pampanga as an example, the gross receipt from its watermelon crop in 1936–1937 season reached to ₱500,000.

The only factors that are taken into consideration in this article in determining the cost of production per hectare are the costs of seeds, the expenses in the preparation of the land, cost of attendant care, supervision, harvesting and transportation. Interests on the value of land or rental, and interest on borrowed capital and other incidental expenses are not included. The depreciation charges on tools and the services of work ani-

mals are accounted for as the services of implements and animals are already evaluated.

FORMS OF TENANCY IN VOGUE

There are many forms of watermelon tenancy existing in Candaba, Pampanga. The most common of these are the following: (1) An uncleaned land is given to a farmer for a year or two for him to clean and raise watermelon. The farmer provides all the expenses but all gross income are his. For the second or third year, the farmer pays 12 to 15 per cent of the total return to the land owner, he, bearing all the expenses in the field. (2) Another system is for the land owner to provide the capital and share 50–50 on the income. (3) Still another system is for the land owner to lend capital to the farmer who pays him 12 per cent interest. Both share the cost of labor and split the net income. This is the form of tenancy in vogue in Bulacan which is also found in Candaba, Pampanga. (4) Many land owners, however, lease their land to the farmers for a definite number of years renewable for another term at the option of the onwer and farmer pays an stipulated amount in advance of the planting dates, or a certain rate on the return from the harvest.

SUMMARY

1. Watermelon is grown commercially in the towns of Candaba and San Luis, Pampanga and in nine towns of Bulacan for the local market and for the neighboring provinces, particularly the City of Manila.

2. There is at present an approximate area of 4,748 to 5,045 hectares devoted to the growing of watermelon in San Luis and Candaba, Pampanga and in the nine towns of Bulacan. These areas are in general worked out by tenancy system.

3. The approximate number of people that are dependent upon the watermelon industry is around 12,992–13,932.

4. The commercial varieties grown in Candaba, Pampanga are De Liston, Ramie and Sta. Rosa White, while in Bulacan—Sta. Maria, Meck, De Jaspe and De Liston are the ones grown.

5. Watermelon planting in Candaba, Pampanga begins from November to February while in Bulacan from the early part of October to December.

6. The approximate expenses for seed, and field operation to grow one hectare of watermelon is ₱212. The gross income,

however is big ranging from ₱300 to ₱500 and ₱900 per hectare, depending upon the stage of selling the fruits.

7. The watermelon crop is disposed either by selling it before maturity or wholesale after harvest.

8. The watermelon crop is subject to a number of insect and disease enemies. The most important disease observed was watermelon wilt. Aphids and squash beetle were also prevalent.

RECOMMENDATIONS

1. The land for the growing of watermelons should be thoroughly prepared.

2. Plant seeds that are of good quality, free from disease and are from good variety.

3. Never plant in land that was previously attacked by pests and diseases.

4. Harvesting and picking of watermelons should be done carefully by the use of knives or pruning shears.

5. Harvest fruits when they are vine-matured.

6. Pests and diseases should be controlled at their first sign of appearance.

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2. Beattle, Wm. Renwick. Watermelon. U. S. Dept. of Agr. Far. Bul. 1394. (1870.)
3. Information from Growers. Data supplied by them to the writer.

ILLUSTRATIONS

PLATE 1

FIG. 1. The Meck variety. The almost total absence of ribbings and dark green color are characteristics of this variety.
2. Sta. Maria variety. Note the dark-green rind and the distinct ribbings, with slight nettings.

PLATE 2

FIG. 1. "De Jaspe" variety. Wide dark ribbings and abundance of light green nettings. Note appearance of flesh, after long distance shipping.
2. "De Liston" variety. The name derived from the distinct stripes or liston. Note triangular hole at cross-section.

PLATE 3

FIG. 1. Ramie variety. Exactly in appearance to the De Liston but heavier and compact.
2. Sta. Rosa White. Note poor keeping quality of fiber-like flesh.

PLATE 4

FIG. 1. A partial view of a watermelon field.
2. A view showing a man harvesting fruits.
3. A view showing picking of harvested fruits.
4. A view, hauling watermelons to the shed.

PLATE 5

FIGS. 1 and 2. Views showing storage of watermelons in the field.
3. A view transporting watermelons to the town.
4. A view where transported watermelons are unloaded. Note the trucks used for carrying watermelons to different places.

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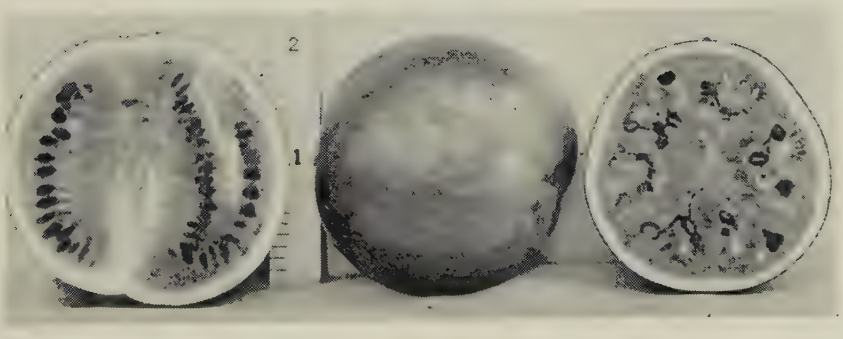

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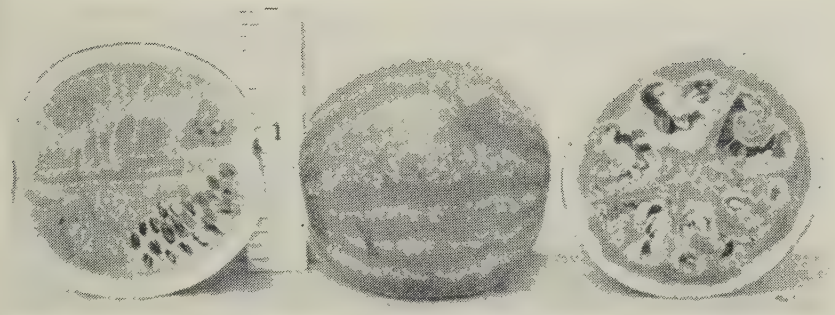
PLATE 1



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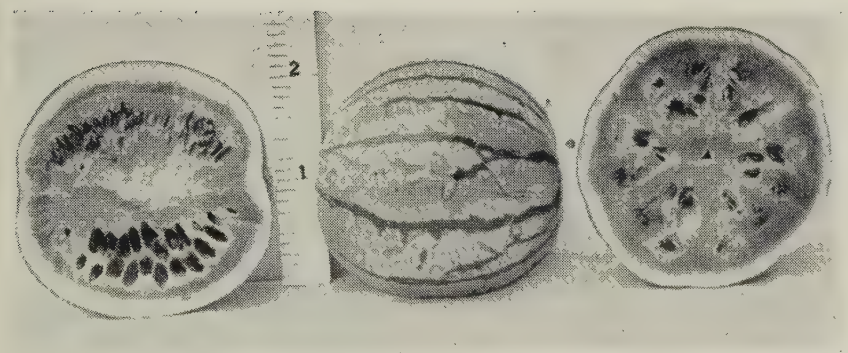

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PLATE 2

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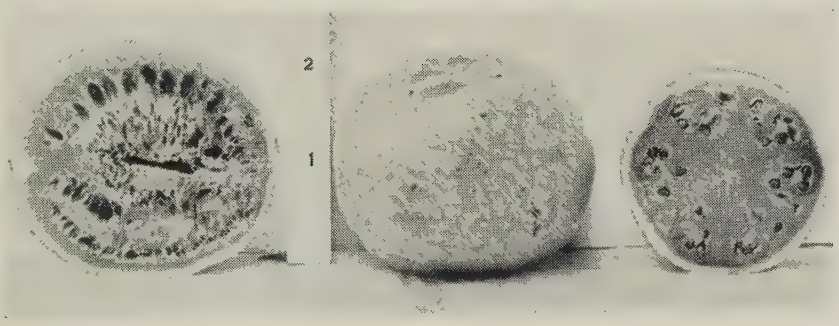

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PLATE 3

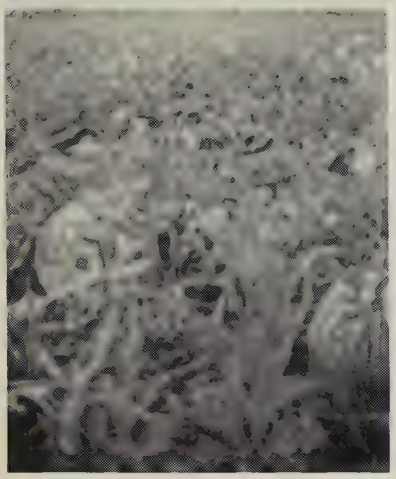

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PLATE 4

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PLATE 5

PALAGAD RICE CULTURE IN THE PHILIPPINES

Farmers' Circular No. 45

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TWO PLATES

The production of a lowland rice crop during the dry season or during the period between two regular wet-season rice crops is of utmost importance in the development of the Philippine rice industry.

Definition.—The term "palagad" literally means broadcast as it was first the practice to broadcast the rice seeds directly over the prepared field of off-season culture. But in this paper the term palagad means collectively all rice cultures during winter (December, January and February) and spring (March, April and May) whether broadcast or transplanted. Naturally in the growing of palagad rice, the supply of irrigation water is essential for success. In other regions where there is a pronounced maximum rain period in winter, the crop is for the most part dependent upon the rain.

Palagad culture is known in various provinces as "Panag-araw" or "Panag-arawan" in Bulacan, Cavite, and Rizal; "Palacaya" in Pampanga; and "Doble" in Sorsogon, but in Laguna where a large crop is raised, it is always called Palagad.

Varieties maturing from March to June when planted during the period from November to March are called palagad rices. Some varieties when planted from February to March mature in July and August, hence they are too long maturing to be included in the palagad group. The palagad varieties may be planted also in the regular wet season but generally are poor yielders, except Guinangang that do as well in the rainy season as in the dry season.

The plasticity in rice gives rise to the formation of thousands of varieties adapted to different conditions(2). It is assumed that the palagad system of cropping was accidentally discovered in some irrigated areas by means of rice volunteers which grew out of season from the rice seeds that dropped to the ground

during the harvesting of the regular crop. The plants, of course, developed normally and gave satisfactory yield during the dry season.

The palagad crop of lowland rice is a sure additional income which may cover the irrigation fees, land tax and the supply of the family's rice to last up to the next harvesting season of a regular-season crop. It ameliorates the living condition of indigent farmers especially on areas that are affected by flood and typhoon.

Soil.—The best soil for palagad rice is clay to clay loam underlaid by a hard pan which retains irrigation water that will maintain the crop to the dough stage.

Seedbed.—An ordinary seedbed prepared by one plowing followed by three to four harrowings with intervals of several days to last 15 and 16 days, may be used. The size of seed bed varies from 333 to 400 square meters for 25 gantas of seeds, enough to plant a hectare. Of course, fertile soil should be selected for seedbeds. The seeds before broadcasting in the seedbed should be soaked overnight and drained for 24 hours to start germination. In regions where there is a long dry season such as in Central Luzon, the seedbed is kept moist to prevent the stunting effect of soil cracking. In places with more humid climate, soil cracking is not common, nevertheless, should the soil show indication of cracking, a moderate irrigation to keep the soil in a saturated condition is essential. The seedlings in the seedbed during the palagad season are less vigorous than those grown at the beginning of the rainy season. A top dressing of about 100 kilograms of ammonium sulphate per hectare will invigorate the seedlings. The seedlings are ready for transplanting at the age of 5 to 6 weeks or younger depending upon the vigor of the seedlings.

In Laguna Province, the "dapog" seedbed is the kind most commonly employed. The method is advantageous as it saves time, space and possibly labor. There are two ways of preparing the "dapog" seedbed. (*a*) The ground is prepared in the ordinary way, by plowing once and harrowing just to puddle and level it. Whole banana leaves (torn leaves patched up), are laid one layer on the surface with the sides overlapping each other, and the prominent midribs down-ward. This layer prevents the roots or rootlets of the seedlings to penetrate into the ground. Pressing the leaves downward carefully will accumulate a thin layer of mud about two centimeters thick for

the seeds to grow on. The seeds, soaked and drained for 36 hours, are then sown. (*b*) Another way which is slightly different from (*a*) consists in putting whole banana leaves on the top of a clean and level ground, and then covering it with either sand or fine chops of rice straw to a thickness of about two inches. Rice husk should not be used as it may harbor organisms that will affect the rice seedlings.

If chopped straw is used, a thin dressing of sand is necessary to cover the interspaces between the chopped straw. After the seeds are sown, a very thin layer of either sand or soil is laid on top to cover the seeds.

On account of the small size of the seedlings to be transplanted, (from 6 to 8 seedlings per hill), an amount of no less than 30 gantas of seeds with good germination is necessary to plant a hectare. A hectare lot requires a seedbed of from 40 to 50 square meters in the form of strips of one meter wide with sufficient length to accommodate the seeds.

Direct broadcasting.—It is a general practice in Pampanga and Bulacan and to a certain extent in Cavite and Laguna to plant direct, by broadcasting, the seeds. However, it has been found by experimentation that the transplanted crop produced from 15 to 20 per cent more than the crop planted by broadcasting.

To avoid hand sprinkling, the seedbeds should be located where irrigation water is available.

Age at transplanting.—The seedlings under the "dapog" system are ready for transplanting from 9 to 12 days after sowing and 5 to 6 weeks under regular seedbed, or just before the node formation of the plants takes place. While in the seedbed the seedlings are kept watered by hand, sprinkling twice a day, morning and afternoon.

Care of the crop.—During hot days the plants are subject to the scalding effect of hot water specially before the plants reach a height of 20 to 25 centimeters. The irrigation water then should be applied in a flush, just enough to saturate the paddies. Even under a more humid climate obtaining in certain rice sections of the Islands, irrigation by flushing should be practised so as to preclude the possibility of drowning the young plants at tender age. When the plants are large enough to shade the entire field, the water may be increased gradually to maintain the crop till just before the dough stage when the water should be released.

Selection of palagad varieties.—One important factor to be considered in the growing of palagad rice is the proper selection of varieties that are suited to different soil types. It has been found that the only variety of rice that is extensively planted in the province of Laguna is Guinangang. Varieties Sipot, Dinagat, Sinadyaya, Inintiw, and Binicol are also planted in commercial scale but the Guinangang variety leads in the area planted and in production. The soil type on which Guinangang, Sipot, Sinadyaya and Dinagat are planted is a heavy clay loam type.

The variety Mangasa is the only variety that is commercially grown in Cavite. The soil type in that province is also of a heavy clay loam but much poorer in fertility than that of Laguna. By way of distinction between palagad Mangasa in Cavite and upland Mangasa in Rizal Province, the former variety has slender stalks and longer type of grains and can be planted also as upland rice while the upland Mangasa from Rizal is purely upland and does not produce grain crop under palagad culture. The upland Mangasa has coarser stalks and much more plump grains than palagad Mangasa.

The variety commonly planted in commercial scale in Pampanga is Pinursigue, an upland variety grown in Batangas Province. In certain sections where the soil is sandy clay loam as in Lubao, the variety Kinawayan is planted. Way back in 1932, the Bureau of Plant Industry started a commercial planting of Guinangang and trial planting of Sipot, Sinadyaya and Kinawayan in Albay Province. The reports received from that province states that Kinawayan is gaining popularity among the rice planters there after five years of trial planting and extension work. In Albay the soil is of volcanic origin with predominating sandy clay loam type, and a clay sub-soil. This corroborates the finding in Lubao, Pampanga.

In 1935 the writer investigated the possibilities of palagad rice culture in Nueva Vizcaya. The varieties found growing in small spots were Pinursigue and Sipot, and were giving the planters encouraging results. The Guinangang variety from Laguna Province was introduced. The success of the crop was amazing (Plates 1 and 2). The soil type in Nueva Vizcaya varies from light clay loam to heavy clay loam. The place where the palagad varieties had been tried is about 2,000 feet above sea level. As to soil type, it is similar to that of Laguna.

In Hagonoy, Bulacan, the variety Pinursigue is planted in a commercial scale. The soil in Bulacan is of hydrosol type(1). The place is annually flooded by the Pampanga River. There is no regular irrigation system except the rising of high tide that cause the water in the river to overflow its bank and irrigate the field. The water is saline or brackish in nature. Other varieties such as Balibod, Macan Aga (local variety), Macan Señora (local variety), Dinolaro, Binuhañgin or Milagrosa and Magsangle are propagated in small scale because the farmers like them, but the general variety raised is Pinursigue which perhaps can best stand under brackish condition. Other places in the Philippines having similar conditions obtaining in Hagonoy, Bulacan, may be able to raise palagad rice.

In the towns of Cardona, Morong, Baras and Tanay in Rizal Province, the general variety used is Kaawa. Guinangang was tried and gave better crop than Kaawa, but it did not attract wide attention for it matures longer than Kaawa. Trial of Sinadyaya was, however, made and one planting gave a yield of 86 cavans to the hectare which, of course, needs further verification. The soil in these places is rich, belonging to Bay clay loam type(1). The soil is a deposit of the Laguna Lake water consisting of well decomposed organic matter. As the lake subsides in coincidence with the dry season, the land is planted and irrigated by river water.

For almost a decade and a half, the defunct Alabang Rice Experiment Station, Alabang, Rizal, had been conducting series of researches on palagad varieties. Of the several hundred varieties tested by the Bureau, only about 20 varieties proved to be amenable to palagad culture. The outstanding seven varieties as regards yield are Sipot, Dinagat, Magsangle, Mangasa, Sinadyaya, Binicol, and Guinangang Str. 1.

DESCRIPTION AND PERFORMANCE OF THE PALAGAD RICE VARIETIES TESTED

Sipot.—This variety is a pure strain isolated from a variety known as Binuhañgin in Siniloan, Laguna. The tillering capacity is fair with medium strength of culms. The variety matures in 155 days. The mean yield is 49.2 cavans per hectare. The eating quality is fair. The yields are shown in Table 1.

TABLE 1.—*Yield of Sipot at the Alabang Rice Experiment Station, Alabang, Rizal, 1921–1932.*

Year tested	Yield per hectare	Year tested	Yield per hectare
	Cavans		*Cavans*
1921	10.0	1927	69.7
1922	29.3	1928	65.9
1923	50.9	1929	55.0
1924	59.4	1930	
1925	50.0	1931	47.8
1926	55.2	1932	47.1

Dinagat.—It is an early variety, maturing in 146 days. This variety used to be popular in Calamba, Laguna. The grains are highly shattering and should be harvested before fully matured. The stooling is fair and the culms are stiff. The eating quality is good. The average yield is 38.5 cavans to the hectare (Table 2).

TABLE 2.—*Yield of Dinagat at the Alabang Rice Experiment Station, Alabang, Rizal, 1923–1927.*

Year tested	Yield per hectare	Year tested	Yield per hectare
	Cavans		*Cavans*
1923	32.1	1926	28.4
1924	44.7	1927	52.6
1925	34.6		

Magsangle.—This matures in 134 days, the earliest among the palagad varieties tested. The tillering capacity is poor and the culms are weak. The cooked rice is rather insipid. Its average yield is 28.4 cavans to the hectare as shown in Table 3.

TABLE 3.—*Yield of variety Magsangle at the Alabang Rice Experiment Station, Alabang, Rizal, 1921–1927.*

Year tested	Yield per hectare	Year tested	Yield per hectare
	Cavans		*Cavans*
1921	8.2	1925	10.0
1922	22.5	1926	49.4
1923	24.6	1927	44.9
1924	39.2		

Mangasa.—This variety is early maturing, 138 days. The tillering habit is rather fair and the culms are fairly stiff. The eating quality is fair. The yield is 39.2 cavans per hectare as shown in Table 4.

TABLE 4.—*Yield of Mangasa at the Alabang Rice Experiment Station, Alabang, Rizal, 1919–1932.*

Year tested	Yield per hectare	Year tested	Yield per hectare
	Cavans		*Cavans*
1919	20.0	1926	44.2
1920	59.2	1927	50.1
1921	40.0	1928	21.1
1922		1929	39.2
1923	45.5	1930	44.4
1924	45.2	1931	30.2
1925	31.6	1932	39.7

Sinadyaya.—It matures in 140 days. The stooling capacity is fair. The culms are medium stiff, and the heading is rather irregular. The performance record on experimental plots at Alabang is 42.5 cavans to the hectare as shown in Table 5.

TABLE 5.—*Yield of variety Sinadyaya at the Alabang Rice Experiment Station, Alabang, Rizal, 1927–1932.*

Year tested	Yield per hectare	Year tested	Yield per hectare
	Cavans		*Cavans*
1927	58.3	1930	35.3
1928	51.9	1931	29.7
1929	48.7	1932	31.1

Binicol.—This is an upland variety which is also used as palagad rice. Under palagad conditions, Binicol matures in 152 days and is not as good as in the upland. It requires very little amount of irrigation water applied to a saturation point only. This condition encourages thick weed growths. Because of its poor adaptability under lowland condition, from 30 to 35 gantas of seeds are needed to plant a hectare. The planting is by broadcasting. The grains are highly shattering. This is planted for fancy rice only, the grains being aromatic.

The average yield is 35.3 cavans per hectare as shown in Table 6.

TABLE 6.—*Yield of Binicol at the Alabang Rice Experiment Station, Alabang, Rizal, 1919–1927.*

Year tested	Yield per hectare	Year tested	Yield per hectare
	Cavans		*Cavans*
1919	13.0	1924	58.2
1920	48.4	1925	34.4
1921	----------	1926	35.4
1922	26.1	1927	39.8
1923	27.4		

Guinangang strain.—This is an isolated strain from the variety Guinangang commercially planted as palagad crop in Laguna Province. It is a dual purpose variety, as palagad and as regular season crops. It can be planted in any part of the year provided that there is water. The tillering capacity is fair, and the culms are stiff. It matures in 159 days. The eating quality is fair. The marked difference of the selected Guinangang and its original stock is that the grains of the former are straw colored with dark brown shade, while the grains of the original stock are also of straw color with slight brown shade, and of semi-bearded type. The average yield is 56.7 cavans per hectare and its record of yields is shown in Table 7.

TABLE 7.—*Yield of variety Guinangang Str. 1 at the Alabang Rice Experiment Station, Alabang, Rizal, 1928–1932.*

Year tested	Yield per hectare	Year tested	Yield per hectare
	Cavans		*Cavans*
1928	72.7	1931	56.0
1929	51.9	1932	48.4
1930	54.8		

The performances of the varieties described above are summarized in Tables 8 and 9. Varieties under Table 8 are early maturing varieties and varieties under Table 9 are late maturing varieties.

TABLE 8.—*Performance of early maturing varieties.*

Variety name	Number of days to maturity	Yield per hectare
		Cavans
Dinagat	146	38.5
Mangasa	138	39.2
Sinadyaya	140	42.5
Magsangle	134	28.4

The early varieties are enumerated in the order of their yielding capacities: Sinadyaya, 42.5 cavans per hectare; Mangasa, 39.2; Dinagat, 38.5; and Magsangle, 28.4 cavans per hectare.

TABLE 9.—*Performance of late maturing varieties.*

Variety name	Number of days to maturity	Yield per hectare
		Cavans
Guinangang	159	56.7
Sipot	155	49.2
Binicol	152	35.3

In the late maturing group, Guinangang Str. 1 is the highest yielder, producing 56.7 cavans per hectare, and Sipot is second, yielding 49.2 cavans per hectare and Binicol is the poorest yielder, giving 35.5 cavans to the hectare.

Palagad rice varieties for different provinces.—The various types of climate and soils in the different parts of the Islands make it difficult to determine new varieties suitable for planting in any one district or province. In regions affected by pronounced wet and dry season, the late maturing varieties are better yielders than the early maturing ones. The harvest of the crops takes place after the dry season has begun. But in regions where there is no dry season or there is only a short dry period, the late maturing varieties are liable to get wet and be spoiled by the rain, consequently it is preferable, as indeed it is the general practice, to plant short-season varieties in such regions.

In Table 10 are given the names of the provinces and the varieties of palagad rice that are already grown there. Also other varieties which are likely to be adapted have been added.

Fertilization and green manuring.—Continuous cropping of lowland rice on the same land exhausts soil fertility. The crop can be brought to normal by the application of a mixture of 150 kilograms each of ammonium sulphate and single superphosphate per hectare. It is applied when the paddies are in saturation point or drained. Weeding is necessary in order to give the rice plants the full benefit of the fertilizers.

Green manuring may substitute chemical fertilizers. Tapilan and mongo, according to analysis made by the Bureau of Science, Manila, contain the necessary elements (Table 11). The planting of legumes such as mongo and tapilan could be

made immediately after the rice harvest, at the rate of 14 to 16 gantas per hectare. The crop at blooming stage should be completely plowed under in order to obtain the best results.

TABLE 10.—*Varieties of Palagad rice for each of 20 provinces.*

Provinces	Varieties recommended for palagad planting
Agusan	Sinadyaya, Kaawa, Mangasa, and Dinagat.
Albay	Kinawayan, Guinangang, Sipot, and Kinarlos.
Antique	Guinangang, Sinadyaya, and Mangasa.
Bataan	Guinangang, Sinadyaya, and Dinagat.
Bulacan	Guinangang, Sipot, Sinadyaya, Kaawa, Pinursigue, and Mangasa.
Cagayan	Guinangang, Sinadyaya, and Mangasa.
Camarines Norte	Kinawayan, Guinangang, Sipot, and Baranay.
Camarines Sur	Kinawayan, Sinadyaya, Kaawa, Baranay, and Kinarlos.
Capiz	Sinadyaya, Guinangang, and Mangasa.
Cavite	Mangasa and Sinadyaya.
Cebu	Sinadyaya, Mangasa, and Dinagat.
Laguna	Guinangang, Sipot, Sinadyaya, and Dinagat.
Leyte	Sipot, Sinadyaya, and Mangasa.
Nueva Vizcaya	Guinangang, Sipot, and Pinursigue.
Pampanga	Kinawayan, Pinursigue, and Balibod.
Pangasinan	Sipot, Guinangang, and Sinadyaya.
Rizal	Kaawa, Sinadyaya, and Guinangang.
Sorsogon	Kinawayan, Guinangang, Sipot, Sinadyaya, and Baranay.
Tarlac	Guinangang, Sipot, Kinawayan, Sinadyaya, and Pinursigue.
Tayabas	Sinadyaya, Mangasa, and Kinarlos.

TABLE 11.—*Fertilizing value of mongo and tapilan.*

Legume	Amount of materials per hectare			
	Amount of dry matter	Nitrogen	Phosphoric acid	Potash
	Kilos	*Kilos*	*Kilos*	*Kilos*
Mongo	3,895.98	97.79	18.30	22.95
Tapilan	4,394.94	98.53	21.97	33.41

Pests and diseases.—The most common enemies of palagad rice are the rice bugs, *Leptocorisa acuta,* Thumberg; leaf folder caused by the larvæ of *Chaphalocrosis medinalis,* Guen.; rice stem-borer caused by the larvæ of a moth, *Schœnobius incertellus,* Wlk.; maya birds, *Munia jagori;* brown rats, *Rattus norvegicus;* leaf spots, *Helminthosporium oryzea,* V; Breda de Haan, etc. Of the most destructive pests of palagad crop are rice bugs, rice stem-borer, rats and birds. No serious losses due to diseases are recorded, however.

SUMMARY AND RECOMMENDATIONS

For palagad rice farming under any type of climate in the Philippines, sufficient irrigation water should be available to maintain and develop the crop to the dough stage.

1. For good results, transplanting rather than broadcasting should be practised.
2. Under limited supply of irrigation water, use only early varieties such as Dinagat, Mangasa, Sinadyaya and Magsangle (short season).
3. Under liberal supply of irrigation water, plant Guinangang and Sipot and if desired, early varieties such as Dinagat, Mangasa, Sinadyaya and Magsangle may as well be planted.
4. For quality or fancy rice, Binicol may be planted.
5. The Guinangang variety can be planted in any part of the year on places provided with irrigation water where the crop will not be affected by floods and other adverse factors.

ILLUSTRATIONS

PLATE 1

Palagad rice of Guinangang variety at heading, Bambang. Nueva Vizcaya.

PLATE 2

A portion of a field of Guinangang. Plants bend down under a heavy burden of grains.

PLATE 1

PLATE 2

THE TALINUM: ITS CULTURE AND USES

Farmers' Circular No. 46

By NICANOR G. TEODORO

Of the Los Baños Economic Garden, Bureau of Plant Industry

FOUR PLATES

The Talinum, otherwise known as the "Fame-Flower," is a plant emigrant from Buitenzorg, Java. Its introduction in Philippine soil, credit for which goes to the defunct Bureau of Agriculture (now Bureau of Plant Industry), dates from January 20, 1920.

A few talinum cuttings received by the old Bureau of Agriculture were sent to the Lamao Horticultural Experiment Station for planting. From that time on, the station has maintained extensive field culturès of talinum. The bulk of the produce are generally shipped to markets in Manila.

When the Los Baños Economic Garden of the Bureau was opened in 1932, a garden culture of talinum was started simultaneously with the other introduced plants. From the plants grown at the garden, cuttings have been secured from time to time for distribution to interested parties. The Vocational Training Division of the Philippine Army, for instance, was the recipient of the biggest consignment of talinum from the Bureau for planting in the Army cadres.

BOTANICAL NAME AND DESCRIPTION OF THE PLANTS

The plant is botanically known as *Talinum triangulare* (Jacq.) Willd., and belongs to the family Portulacaceæ.

It is a fleshy, erect, perennial herb (Plate 1, Figs. 2 and 3), reaching a height of about 1 meter, and is inclined to become woody at the base with age. The leaves are formed like a spatula, being spoon-shaped, arranged alternately and are fleshy and succulent. The inflorescence (Plate 2, Fig. 2) has a long three-angled stem, about 30 cm. long with lateral rachises, and many flowered-racemes. The flowers (Plate 2, Figs. 1, 3, 4 and 5) measure from 1.5 cm. to 2.5 cm. in diameter, with a corolla of five red petals, and a green calyx of two sepals. The capsules (carpels) or fruits (Plate 2, Figs. 6 and 7) are egg-shaped, 3-valved, containing 50 to 60 puny seeds which are black and kidney-shaped.

METHODS OF PROPAGATION AND PLANTING

The plant can be propagated by seeds and by cuttings.

It is very productive, and so remarkably instantaneous in growth that in districts like Tondo, Manila, where congestion practically leave no room for the pursuit of gardening in the premises, the talinum can readily be raised in window boxes or in cans (Plate 1, Fig. 3).

If the seeds are used, they are sown in boxes or in a small plot in the ground (Plate 1, Fig. 1). In the latter case, they are sown in rows about 30 centimeters apart, and the seedlings are either pricked or planted direct into permanent plots in the fields, at distances of 1 meter in rows 1 meter apart. These distances will render cross cultivation possible while the plants are young or until the crop has attained considerable size.

As the plant is conveniently and quickly produced by using cuttings, this method of propagation is preferred to that of seeds. Cuttings (Plate 3, Fig. 3), 15 to 20 centimeters long, are prepared from any portion of the plant from the main stem or branches, as both young and old parts will grow. Precaution should be taken to remove all leaves from the cuttings before planting, in order to avoid rapid transpiration which drains the cuttings of their vitality and causes them to die. The same distance of planting observed in the case of transplanting seedlings described above, holds true in the case of cuttings, i.e., setting the cuttings 1 meter apart in the row and 1 meter between rows. The cuttings are planted in the center of the furrows in a slanting position to a depth of 8 to 10 centimeters. As previously stated, the distance of 1 meter between furrows facilitates cultivation which should be done about two or three weeks immediately after planting.

Trials at the Economic Garden have indicated that talinum can be grown feasibly in all seasons of the year but requires a soil sufficiently rich in humus.

HARVESTING THE TOP-ENDS AND THE SEEDS

After six or seven weeks from the date of planting, several lateral branches are produced and harvesting of the top-ends or young shoots (Plate 4, Figs. 1, 2 and 3) can be fairly started. This is done by simply breaking off the young, tender top-ends from the branches.

In order to obtain seeds, a few plants are to be left alone, i.e., the top-ends are not harvested from them, so as to allow the flowers to develop and the carpels to mature.

As soon as the flowers start to fall off, the light colored carpels or fruits (Plate 3, Fig. 1) are primed for harvest. These carpels are brittle and can be crushed between the fingers so as to liberate the seeds. When the plants have produced numerous branches which become so dense, the old plants are ready to be replaced with new ones by planting cuttings or seeds (Plate 3, Fig. 2) obtained from the mother plants.

COST OF PRODUCTION AND YIELD

The operations involved in the preparation of land for the planting of talinum on a commercial scale are practically identical with that of planting sweet potato. It is estimated that a hectare of this crop would yield about 12 tons of the young shoots, at the rate of 1.2 kilos per plant, or a gross return of approximately ₱1,200 per annum per hectare. Of course, it is to be expected that the ease of production may clog the market and lower the price very promptly.

UTILITY OF THE PLANT

Talinum, besides being an ornamental and pot-herb (Plate 1, Fig. 2), is an excellent source of greens (gulay), and contributes materially to a properly balanced diet of the people. Analysis of the young shoots or top-ends gives 91.26 per cent water, 1.56 per cent ash, 0.80 per cent crude fiber, 1.23 per cent protein, 0.45 per cent fat, 4.70 per cent carbohydrates, and 277 calories per kilo of food.

The Plant Utilization Division of the Bureau of Plant Industry has extensively experimented on the preparation of talinum for the table and has evolved at least 80 recipes using talinum as the main ingredient. The said Division found the following facts about talinum:

It is easily prepared; it seems to keep longer than many other leafy vegetables; it has no raw vegetable flavor which is present in many vegetables and which is eliminated by cooking; it combines satisfactorily with meats, fishes, mollusks, and other vegetables and, therefore, makes a good soup, a delicious salad, a main dish, and a satisfactory dessert. One advantage of the talinum over some common leafy vegetables is that it can be served raw, blanched, or cooked. When served raw, it is strongly recommended that it be soaked in a dilute lime solution for

a period of between 5 to 10 minutes to be sure that it is safe. Some of the popular recipes for talinum are as follows:

TALINUM SINIGANG

1 cup talinum
2 cups rice water
1 medium sized bañgos (cut into 4 pieces)
4 tomatoes, regular size
10 camias, large
2 hot peppers
1½ teaspoonfuls salt

Boil tomatoes and camias in rice washing until soft. Add hot peppers and salt; then add the fish. Let it simmer until fish is done. Add talinum before serving.

TALINUM BULANGLANG

1 cup talinum
1 eggplant (cut to pieces)
1 amargoso, medium size (cut to pieces)
½ cup string beans (cut 1 inch long)
½ bañgos or dalag, broiled
1 tablespoonful bagoong
2 segments garlic
1 table spoonful lard
¾ cup rice water

Sauté garlic and bagoong. Add string beans, amargoso, and eggplant. Add fish, then the boiling rice washing. Let boil for 5 minutes. Add talinum before serving.

TALINUM PINACBET

2 cups talinum
3 teaspoonfuls bagoong
1 small tomato, sliced
1 small onion, sliced to pieces
⅓ cup "chicharon," broken to small pieces
⅓ cup stock

Place tomato and onion together with the bagoong in the stock. Boil and add the washed talinum and the "chicharon" a few minutes before serving.

GULAY

1½ cups talinum
1 cup cassava (fresh) sliced into narrow strips
¼ cup shrimp
¼ cup pork (cut to pieces)
1 segment garlic
1 tablespoonful lard
2 cups shrimp and pork stock

Sauté garlic; add pork and shrimp previously boiled in 2½ cups water. Add stock and let boil. Add cassava and boil 5 minutes. Add talinum before serving. Serve hot.

TALINUM PULUTAN

1 cup talinum
⅔ cup green mango
⅓ cup tomatoes
3 tablespoonful patis

Soak talinum in lime solution for 10 minutes. Rinse with drinking water to remove excess lime. Slice crosswise to about ¼ inch wide. Cut tomatoes to small cubes and the mango to very small pieces. Mix all ingredients.

(Lime solution may be made by dissolving 1 teaspoonful of lime (CaO) in about 2 quarts of water.)

ILLUSTRATIONS

Plate 1

Fig. 1. Two plots of talinum in the nursery of the Los Baños Economic Garden, Los Baños, Laguna.
2. A talinum plant growing in the open field.
3. A talinum plant growing in a petroleum can.

Plate 2

Fig. 1. Sketch of a young shoot of talinum.
2. Diagram of inflorescence of talinum.
3. Sketch of talinum flower.
4. Vertical section of the flower of talinum.
5. Horizontal diagram of the talinum flower.
6. Sketch of the side view of a carpel of talinum.
7. Vertical section of a carpel of talinum.

Plate 3

Fig. 1. Capsules (carpels) or fruits of talinum newly harvested for curing.
2. Seeds of talinum.
3. Stem cuttings of talinum, at various stages, for planting.

Plate 4

Fig. 1. Young shoots of newly harvested talinum for food.
2. Young shoots of talinum being prepared for shipment, using banana sheaths.
3. Young shoots of talinum packed for the market.

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PLATE 1

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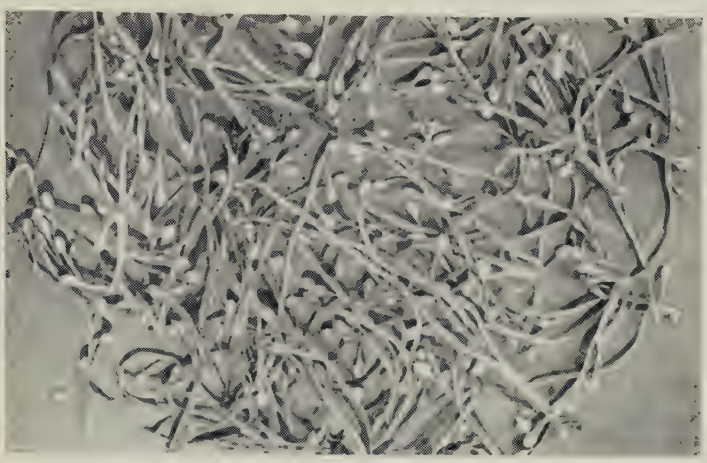
PLATE 2



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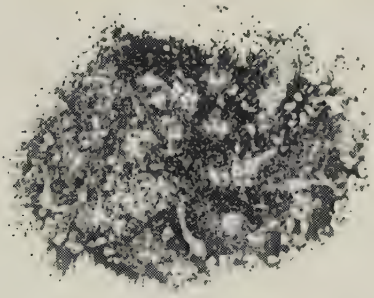

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PLATE 3

1

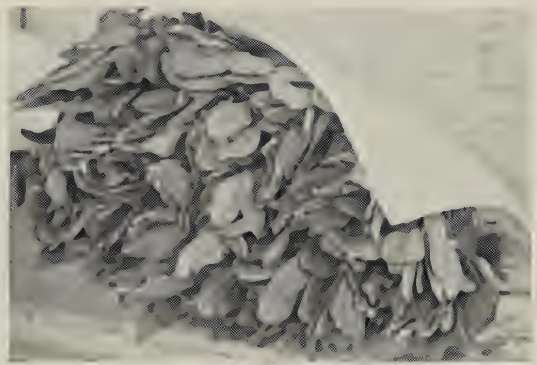

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PLATE 4

EGGPLANT DISEASES AND THEIR CONTROL

(Farmers' Circular No. 44)

By MACARIO A. PALO
Assistant Plant Pathologist, Bureau of Plant Industry, Manila

SEVEN PLATES

Eggplant is one of our important and popular vegetable crops in the Philippines. It is found in almost every home garden and in some places, it is grown on a large scale for shipment to nearby markets. Owing to increased hectareage, its production has risen from 10,170,600 kilos valued at ₱387,140 in 1933 to 10,800,120 kilos valued at ₱421,520 in 1936. The average production by weight of eggplants per hectare in the Philippines is low, being only about one-fourth of that of the United States and probably lower than that of India, China, and Japan.

One of the causes of the low production of eggplants in the Philippines is the attack of diseases. With the widespread distribution and continued planting of eggplants, diseases were gradually introduced and have become more firmly established in places where they are grown frequently on the same land. Now, some of these diseases are considered the main limiting factors in profitable commercial eggplant growing in the Philippines. There are times when they cut down the yield to about 10 to 50 per cent or ruin the entire crop in certain places. Their destructiveness is enhanced by warm, moist weather, thus, their outbreaks are often more severe during the wet months than during the dry months of the year. Greater loss is experienced by the growers when two or more diseases (Plate 1, figs. 1 and 2) occur in the same field.

The diseases which are commonly observed to be destructive on eggplants in the Philippines are damping-off, bacterial wilt, Phomopsis disease, Phytophthora disease, root-knot and stem-rot. The other diseases of eggplants such as leaf-spot, rust and anthracnose have been reported in the Philippines but they have not been observed to occur in an alarming proportion.

Serious outbreaks of eggplant diseases could be prevented and considerable amount of loss could be reduced if the growers

are acquainted with their nature and their cause, the factors affecting their outbreaks and the simple practical methods of stemming their ravages. It is, therefore, the purpose of this circular to bring together for the benefit of eggplant growers all of the important and useful information concerning eggplant diseases and their control.

MAJOR EGGPLANT DISEASES

DAMPING-OFF

The disease known as damping-off is the most common and most destructive of all seedbed diseases of eggplants. The disease is not caused by dampness as its name implies but by a number of parasitic organisms which develop under damp conditions.

Symptoms.—The disease can readily be recognized by the falling-over or wilting of young eggplant seedlings (Plate 2, fig. 1). Upon examining the affected seedlings it will be observed that the parts of the stems at or near the level of the ground are water-soaked. The disease in the seedbed usually begins in few spots which gradually spread in more or less circular form. The seedlings may all be destroyed if the existing conditions continue to be favorable for the spread of the disease. A thin cobweb-like growth of the causal fungus may be seen on the surface of the soil and on plants which have fallen over. As the seedlings grow older and become more woody they become more resistant to the disease. Very often the seedlings outgrow the disease. Such seedlings may look normal but commonly their stems are constricted or may show sunken, brown scars at points of infection.

Cause.—Damping-off of eggplant is commonly caused by either a soil-borne fungus known as *Rhizoctonia solani* Kuhn, or by a seedborne fungus known as *Phomopsis vexans* (Syd. & Sacc.) Harter. *Sclerotium rolfsii* Sacc., another common soil-inhabiting fungus, also causes damping-off of eggplant (Plate 2, fig. 2) but it is seldom observed in seedbeds. *Rhizoctonia solani* and *Sclerotium rolfsii* are capable of living in the soil as saprophytes feeding on organic matter and when favorable conditions occur they become active parasites. They are also capable of passing over an unfavorable weather by means of specialized fungus bodies known as sclerotia.

Control.—Sterilization of the soil is one of the surest ways of controlling the damping-off organisms in seedbeds. To be ef-

fective, it should be made thorough, to make sure that the damping-off fungi are all killed. Soil sterilization can be accomplished by either steam, surface-firing, roasting or chemicals. Formalin (one part of commercial formalin to fifty parts of water) applied at the rate of about 1.5 liters to one square foot of soil in seedbeds is the usual amount of chemical used in sterilizing soil. Only healthy seeds should be planted because no amount of sterilization can rid the seedbed of damping-off caused by *Phomopsis vexans* if the seeds are contaminated with this fungus. Where soil sterilization is not feasible, eggplant seedlings can sometimes be grown successfully in seed flats containing virgin soil or any soil that has not been cultivated. However, there is no assurance that such soils are always free from damping-off fungi.

Crowded planting in seedbeds should be avoided because it creates a condition that promotes rapid growth and spread of damping-off organism. The beds should be located where they could be exposed to the sun during a certain part of the day so as to dry off the excessive moisture in the soil and prevent the rapid development of damping-off fungi. Frequent stirring of the soil between rows of seedlings is also beneficial in checking the disease. If a certain part of the seedbed becomes infected, the healthy seedlings may be saved by pricking them out into new beds or by removing the soil and plants in the infected area completely out of the seedbed.

BACTERIAL WILT

The bacterial wilt is the most serious disease of eggplants in the field. Wet weather coupled with high temperature is most conducive to its development and rapid spread. During such weather many plants perish and the disease usually assumes an epidemic proportion.

Symptoms.—The bacterial wilt attacks the eggplant at any stage of its growth in the field. The most conspicuous symptom of this disease is the wilting of the foliage which may first be observed a few weeks after transplanting the plants in the field. The early indication of the presence of the disease is the drooping of a number of leaves on one or more of the branches (Plate 3, fig. 1). The veins and midribs of affected leaves become soft and limp and the tissues between the veins become pale green or brown. Gradually, more branches are involved until wilting becomes prominent (Plate 3, fig. 2). Plants which show only

partial wilting recover during the night when transpiration is low. When the stem of a wilted plant is cut across, the woody part shows brown discoloration. The discolored parts are the water-conducting vessels filled with bacteria whose presence interferes with the free movement of water and food materials from the roots to the leaves, ultimately resulting in the wilting of the plants. On pressing the cut stem, a slimy dirty-white matter which is composed mainly of bacteria, oozes out of the cut end.

Cause.—This disease is caused by *Bacterium solanacearum* E. F. S. = *Phytomonas solanaceara* (E. F. S.) S. A. B. The organism gains entrance into the plant mainly through injuries caused by insects and nematodes and wounds inflicted upon the roots during transplanting and cultivating the plants. Within the host tissues the bacteria multiply rapidly and are later liberated in the soil upon the death and decay of the affected plants. In the soil the bacteria can remain alive for a long time even without any susceptible growing host, thus making it impossible to grow eggplants and other susceptible crops profitably in the same field from one year to another.

Control.—The bacterial disease of eggplant and its relatives are very difficult to control. The control of this disease by destroying the parasite in the soil with chemical agents is not only impractical but also very expensive to follow in big-scale planting of eggplants. The treatments of soils with acids or alkalies in amounts sufficient to kill the organism render the soil unfit for the cultivation of many plants, hence, no benefit is obtained from this method. The most effective control so far found for this disease is strict sanitation, systematic crop rotation and planting of resistant varieties.

A system of crop rotation in which no eggplant or any of the wilt-susceptible hosts are planted for at least three or four years, is highly beneficial. Such plants as tobacco, pepper, tomato, potato, tañgo, castor bean, cosmos, marigold, and cockscomb have been reported in the Philippines as susceptible to bacterial wilt and should, therefore, be excluded in the crop series. As a precautionary measure, the following cultivated plants such as watermelon, velvet bean, sweet potato, cowpeas, soybeans, peanuts, and peas and ornamental plants such as dahlia, petunia, and sunflower have been reported in other countries as subject to the attack of wilt organism and should not also be included in the rotation system. In order to completely starve out the

organism, such weeds as unti-untian (*Physalis minima*), potókan (*Physalis angulata*), kolites (*Amaranthus gangeticus*), damong pallas (*Ageratum conyzoides*) and *Spilanthes acmella* which also serve as hosts of the disease should not be allowed to grow in the field. Rice, sugar cane, corn, cotton, garlic, ginger, gabi, ubi, tugue, casava, sincamas, tapilan, and derris are not known to be affected by the disease and can, therefore, be used in the rotation system.

No eggplant variety has as yet been found to be immune to the wilt disease. However, such varieties as Big Japanese Purple (Plate 4), Pampanga White and certain strains of Big Japanese Purple × Native Long when planted in wilt-infected field appeared to be very resistant to the disease. The only objection to Big Japanese Purple and Big Japanese Purple × Native Long is that they are among the varieties found to be most susceptible to Phomopsis disease. Iloilo Purple was also observed to be moderately resistant to the wilt disease.

PHOMOPSIS DISEASE

The Phomopsis disease is widespread in the Philippines. It may occur on eggplants at any time of the year but it usually attacks them more seriously during the rainy or humid months than during the dry months.

Symptoms.—The Phomopsis disease attacks all parts of the eggplant above the ground, producing different types of symptoms on different parts.

The disease on the seedlings originates usually from infected or contaminated seeds. Seedlings affected damp-off, fall over, and die.

On the stems of mature plants the disease produces brown or light brown, oblong or irregular, sunken, dead areas which with age develop into a form of dry rot or canker. Plants seriously attacked by the disease on the main stems wilt and die prematurely. When a tender stem is attacked the affected part shrinks rapidly and sometimes tips over because the weakened tissues are unable to support the weight of the foliar part. In later stages of the disease the affected parts of the stems may be covered by minute, black pustules, the fruiting bodies of the causal fungus.

On the leaves, the disease produces irregular brown spots with blackish brown margin (Plate 5, fig. 1). These spots are shown more conspicuously on the lower, older leaves than on the upper, younger ones. The presence of many of these spots

cause the dropping-off of the leaves, hence on seriously attacked plants only the younger, upper leaves are usually left (Plate 1, fig. 3). On old spots minute, black pustules are also produced.

On the fruits the disease produces soft, sunken, light brown depressions which tend to merge together, when numerous, into large dead areas (Plate 5, fig. 2). Numerous black pustules (Plate 5, fig. 3) develop on the rotting parts of the fruit. Under dry weather conditions the rotting fruits shrink fast and mummify as black, hard bodies.

Cause.—The Phomopsis disease is caused by a fungus known as *Phomopsis vexans* (Syd. & Sacc.) Harter. The organism produces fruiting bodies which appear as minute, black pustules on the attacked parts of the eggplant. Within these black bodies are numerous spores which correspond to the seeds of the higher plants.

Control.—Since the disease is seed-borne, it is absolutely necessary to obtain the seeds from healthy, vigorous plants. Seeds of an unknown source should be soaked in a solution of corrosive sublimate (one gram in 1000 cc. of water) for 10 minutes or in a solution containing one part of commercial formalin and 300 parts of water for 15 minutes before planting. In the absence of the above disinfectants the seeds should be soaked in hot water for 30 minutes at 50° C. or for 10 minutes at 55° C.

As soon as the crop is over, the plants in an infected field should be pulled out and burned to kill the organism and eliminate the source of infection for other fields of eggplants in the neighborhood. Eggplants should not be planted in severely infected fields for at least three years in order to starve out the causal fungus.

Spraying with Bordeaux mixture (bluestone, 1 kilo; quick lime, 1 kilo; water, 100 liters) 5 or 6 times at weekly or biweekly intervals has been found satisfactory in controlling the disease in the field. The first spraying should be given as soon as the early symptoms are noticed. For effectiveness of the spray, it should be applied in fine mist with a compressed air sprayer or hand pump and should be directed to the stems and lower and upper surfaces of the leaves.

The selection and planting of resistant varieties or strains should also be done as a means of controlling the disease. The Pampanga White Variety has been observed to be very resistant to the Phomopsis disease but resistance to this malady does not

insure its resistance to the Phytophthora disease to which its fruits were found to be very susceptible. Iloilo Purple and Lemery varieties were observed to be fairly resistant to Phomopsis disease.

PHYTOPHTHORA DISEASE

The Phytophthora disease is frequently the cause of severe rotting of the fruits in the field during wet weather. No serious case of this disease was observed during hot weather. At the Lipa Coffee-Citrus Station it destroyed about 50 per cent of the fruits of the Pampanga White variety during the months of September and October, 1937.

Symptoms.—The Phytophthora disease attacks both the leaves and fruits. On the leaf it appears in the form of large, blighted areas which sometimes involve the entire leaf. No serious cases of blighting of the foliage due to this disease were observed in the field.

On the fruits the disease is more commonly found on low-hanging ones than on those set on the upper branches, indicating that the source of infection is contaminated soil. Affected fruits show circular to irregular dark-brown patches which are usually a few millimeters in diameter. During moist weather the diseased areas enlarge rapidly until the entire fruit rots. A distinct cotton-like growth of the causal fungus (Plate 6, figs. 1 and 2) usually develops on the rotting tissues. With age the cotton-like growth becomes flat and turns into a dirty-white felt on the surface of the diseased areas. Badly attacked fruits drop off from the calyx-lobe and then disentigrate.

Cause.—The Phytophthora disease of eggplants is caused by a fungus known as *Phytophthora melongenæ* Sawada. The white cotton-like growth that develops on the rotting fruits consist of mycelium or vegetative parts and spores or the seed bodies of the fungus. Upon the disentigration of the diseased leaves and fruits, the fungus is left in the soil where it may remain alive until the next season. The fungus is carried from one place to another with the soil and debris on farm implements, feet of men and animals and by surface water during the rain. From the soil the fungus is splashed with soil particles to the leaves and fruits and cause infection if conditions are favorable for the development of the fungus.

Control.—The Phytophthora disease can be controlled by spraying with 4-4-50 Bordeaux mixture once every two weeks or oftener during the rainy season. In a place where this

disease is already known to occur, spraying should begin as soon as the young fruits are formed. The plants should be examined from time to time and as soon as the disease is detected the affected parts should be removed and then buried or burned in pits. This procedure will prevent too much contamination of the soil, and also, will reduce infection for the forthcoming fruits. The disease may also be greatly minimized by planting the eggplants at least one meter apart in order to establish conditions less favorable to the development of the disease by permitting free circulation of air and admitting plenty of sunshine.

ROOT-KNOT

Root-knot is one of the most widespread diseases of our cultivated plants, weeds and many grasses. Plants cultivated in light, sandy or loamy soils are more seriously affected with root-knot than those grown in heavy clay. Prolonged high soil temperature seems to favor serious outbreaks of this disease.

Symptoms.—The disease may readily be recognized by knot-like enlargements or swellings on the root system (Plate 7, fig. 1). The enlargements may vary in size from small knotty appearance on finer roots to large, elongated swellings on bigger roots. The presence of the swellings slows down the movement of the food supply of the plant, hence, badly affected plants show pale green or light yellow leaves and appear dwarf or stunted. Seriously affected plants wilt, especially during dry, hot weather and may die after several days. The disease attacks eggplant in any stage of its growth. Plants infected during their seedling stage may die before they develop many leaves or produce many fruits. Plants infected during their mature stage may continue to produce some fruits but such plants show slower growth and lighter green leaves than healthy ones.

Cause.—Root-knot is caused by *Heterodera marioni* (Cornu) Goodey = *Heterodera radicicola* (Greef) Müller, a minute animal commonly called nematode or eelworm (Plate 7, fig. 4). The young eelworms work their way through the soil and invade the plants they prefer by boring into the roots. The presence of these animals in the tissues irritate the plants causing them to form knot-like swellings on the roots. Upon breaking the old swellings, minute, pearly, white, pear-shaped bodies may be seen. These bodies are the enlarged egg-bearing female nematodes. A mature female (Plate 7, fig. 2b) may lay hundreds of eggs (Plate 7, figs. 2a & 3) which hatch within the root-knot

tissues into active forms or eelworms. Upon the disentigration of the root-knot tissues the eelworms escape and live for sometime in the soil until they come in contact with the fresh roots of susceptible plants.

Control.—A three-year crop rotation, which is accompanied by clean cultivation to eliminate the weed hosts of the nematodes and in which only immune and highly resistant crops are planted, is the most satisfactory method of controlling root-knot in an infested field. Peanuts, onions, parsnip, turnip, garlic, sincamas, seguedillas, rice, corn, and velvet bean are either immune or highly resistant to root-knot and, therefore, may be grown in rotation system. Proper precautions should be taken to prevent the occurrence of the disease in seedbeds by sterilizing the soil or using only soil known to be free from nematodes. Seedbeds should be located in newly opened grounds and where this cannot be done, the soil should be sterilized with either steam or chemicals. Seed flats can be rid of nematodes by pouring boiling water (about one kerosene can of boiling water in a flat (18 × 24 inches) into the soil. Root-knot infection may also be greatly reduced by flooding the infested field for thirty-five to forty days and also by constant stirring and exposing the infested soil to the sun during the dry, hot weather.

STEM-ROT

Stem-rot is a very common disease of our cultivated and weed plants. No serious outbreak of stem-rot of eggplants was observed in the field, but once the plants are attacked by this disease, they are usually killed.

Symptoms.—The disease is characterized by rotting of the tissues at the base of the plant. Under humid conditions an abundant growth of fine, white mycelial threads may be seen covering the brown rotting tissues (Plate 2, fig. 3). Numerous spherical bodies which are white while young and brown with age develop on the mycelial web. The presence of these bodies, which are about the size of mustard seeds is the most important diagnostic sign of the disease. Affected plants wilt and die usually after the mycelial web has completely encircled the stem.

Cause.—The stem-rot of eggplant is caused by a fungus known as *Sclerotium rolfsii* Sacc. The spherical bodies which develop on the mycelial web are known as sclerotia. The sclerotia are the usual means of propagating the fungus and are very resistant to adverse weather, hence, they serve in the same way as

seeds in carrying the fungus from one season to another. When the conditions are favorable for their growth, they germinate and cause infection when they come in contact with susceptible plants.

Control.—Since the causal fungus attacks a large variety of plants, crop rotation as a control measure is very impractical. The most practical method of controlling stem-rot is careful removal of the affected plants together with the sclerotia and then dumping and burning them in pits. Other important measures are clean culture, avoidance of close planting in infected field and prevention of the spread of the fungus to uninfected places.

MINOR EGGPLANT DISEASES

The other diseases of eggplants which have been reported in the Philippines are generally considered of minor economic importance. Those which are well known are anthracnose caused by *Gloeosporium melongenæ* Sawada, rust, caused by *Puccinia tubulosa* (P. & G.) Arth., and leafspot caused by *Cercospora melongenæ* Welles. Anthracnose causes blighting of the leaves and shoots and also rotting of the fruits. Rust and leafspot attack mostly the leaves.

Planting of healthy seeds, strict sanitary measures, proper cultural methods and crop rotation will hold any of the above diseases in check. Should any one of them show sign of becoming serious because of unusual weather conditions, the plants should be sprayed with 4–4–50 Bordeaux mixture. The applications of this spray should follow in all their details those for the control of Phomopsis disease on eggplants in the field.

ILLUSTRATIONS

Plate 1

Fig. 1. A garden containing different varieties of eggplants badly attacked by both Phomopsis disease and Phytophthora disease. Note the number of fruits that have fallen due to these two diseases.

2. Eggplant fruits gathered from the garden shown in fig. 1. Healthy fruits (left), fruits attacked by Phomopsis disease (middle), fruits attacked by Phytophthora disease (right).

3. Japanese Purple eggplants heavily defoliated by Phomopsis disease.

Plate 2

Fig. 1. Showing infection of eggplant seedlings by damping-off due to *Rhizoctonia solani.*

2. Damping-off of eggplant seedlings due to *Sclerotium rolfsii.* Note the white mycelial growth of the fungus and the formation of young sclerotia which appear as small, white, spherical bodies on the mycelial web.

3. Basal portion of the main stem of eggplant affected with stem-rot. Note the white growth of the causal fungus *Sclerotium rolfsii* on the rotting part of the stem.

Plate 3

Fig. 1. An eggplant showing the early signs of wilt disease caused by *Bacterium solanacearum.* Note the drooping of a number of leaves on the upper left part of the plant.

2. An eggplant showing prominently the signs of wilt disease due to *Bacterium solanacearum.*

Plate 4

Eggplants grown in wilt-infected field. The Isabela variety (two rows at left) is very susceptible to the wilt disease caused by *Bacterium solanacearum* while the Japanese Purple variety (two rows at right) seems to be highly resistant to the same disease.

Plate 5

Fig. 1. An eggplant leaf showing the typical leaf-spot symptoms of Phomopsis disease.

2. An eggplant fruit attacked by Phomopsis disease.

3. A portion of an eggplant fruit attacked by Phomopsis disease showing the development of numerous black pustules, the fruiting bodies of the causal fungus (*Phomopsis vexans*).

PLATE 6

FIG. 1. Phytophthora disease on Pampanga White fruits of different stages. Note the cotton-like growth of the causal fungus *Phytophthora melongenæ*.

2. Phytophthora disease on an eggplant fruit of the Lemery variety. Note that the entire fruit is almost covered by the cotton-like growth of the fungus.

PLATE 7

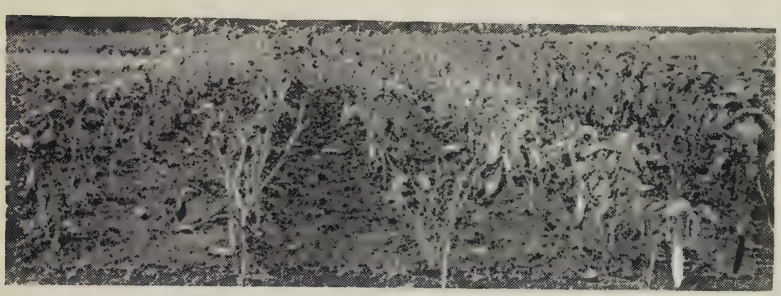
FIG. 1. Root system of an eggplant showing the root-knot disease caused by an eelworm *Heterodera marioni*.

2. Egg sack (*a*) and mature female of root-knot nematode (*b*), about × 54.

3. Various stages in the development of the egg of root-knot nematode, about × 204.

4. Larva or young nematode. This is the most active part in the life-cycle of this animal, about × 134.

5. Mature male nematode, about × 135.



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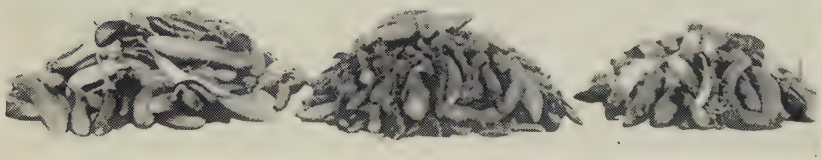

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PLATE 1

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PLATE 2

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PLATE 3

PLATE 1

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PLATE 5

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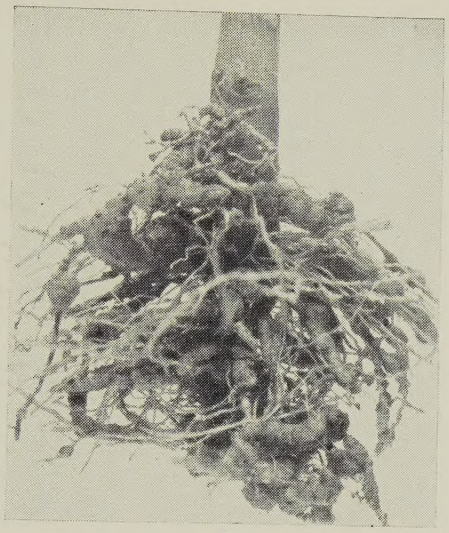
PLATE 6



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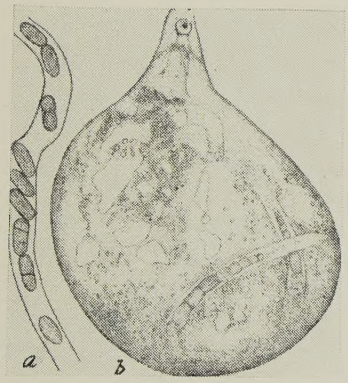

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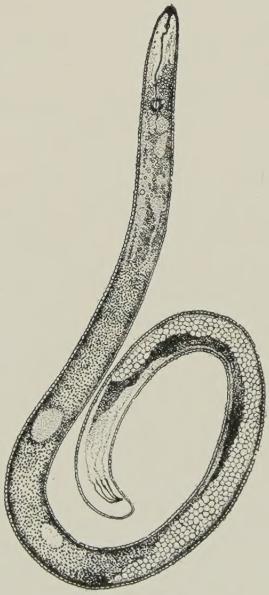

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PLATE 7

BUREAU OF PLANT INDUSTRY

AGRICULTURAL STATIONS

1. Central Experiment Station, Manila
2. Lamao Horticultural Station, Limay, Bataan
3. Lipa Coffee-Citrus Station, Lipa, Batangas
4. Tanauan Citrus Station, Tanauan, Batangas
5. Granja Sugar-Cane Station, La Granja, Occidental Negros
6. Gandara Seed Farm, Gandara, Samar
7. Baguio Plant Industry Experiment Station, Baguio
8. Maligaya Rice Station, Muñoz, Nueva Ecija
9. Ilagan Tobacco Station, Ilagan, Isabela
10. Maridágao Rubber Station, Pikit, Cotabato
11. La Paz Propagation Station, La Paz, Iloilo
12. Los Baños Economic Garden, Los Baños, Laguna
13. Sta. Maria Propagation Station, Sta. Maria, Ilocos Sur

SUBSTATIONS

1. Davao Seed Farm, Davao Penal Colony, Davao
2. Halcon Rubber Substation, Baco, Mindoro
3. Gingoog Lanzon Reservation, Gingoog, Oriental Misamis
4. Mandaue Seed Farm, Mandaue, Cebu

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